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City-Manager Plan

SO much has been said recently about the commission-manager plan of municipal government that engineers and contractors are familiar with the general scheme and the theory on which it is based. It is worth while, however, to get the views of the person who should be the most competent to discuss the subject, and attention is, therefore, directed to the abstract on page 279 of Mr. Waite's remarks at Indianapolis. The keynote of the new plan, as he puts it, is efficiency. Jobs are the reward of merit and competence, not of vote-getting ability. Furthermore, full publicity is absolutely necessary, for unless the people have all the facts, so that they can understand the city's problems and management, public interest and confidence cannot be gained, and that being absent, the needed support will be lacking. Support, too, is more necessary for an honest government than for a dishonest one, for only one faction will be actively arrayed against the latter, but all the forces of evil are combined against the former. "In the ultimate analysis," as Mr. Waite says, "it is the intelligent interest on the part of the citizens in their own municipal government on which the success of any form will depend."

A Report Beyond Controversy

HEARTY commendation should be accorded Morris L. Cooke, director of the department of public works of Philadelphia, for his wisdom and courage in securing on the League Island Park scandal a report so unmistakably impartial and disinterested that the system excoriated cannot attack it or try to belittle the findings on the plea of political motives. If the citizens of Philadelphia do not rise en masse to punish, if still possible, the system—former city officials, engineers, contractors and inspectors—involved in the scandal, then the promise held out by the election of a reform mayor there some years ago was false. From start to finish the object of building the works seems to have been to furnish employment—fat profits—for crooked contractors rather than to provide a necessary or desirable construction. If any reader does not understand how an even-tempered judicial document can be scathing, he is referred to the abstract of the report on page 271. The fearless recital of conditions disclosed and the fixing of the responsibility are the severest possible arraignment of the Philadelphians responsible. The appointment of so eminent a body of specialists, so far above suspicion of bias or of being improperly influenced, to report on this matter may well form an object lesson for city officials. If public opinion cannot be aroused by such handling of a situation of this sort, then there is no hope for better things from the citizens concerned.

Engineer as Master in Chancery

ONE is inclined to remark, after reading the note in last week's issue of the Engineering Record regarding the decision of an engineer who had been appointed a master in chancery, that the engineer is "coming into his own," the remark being influenced, too, by recognition in other directions of the standing of the engineer—as by appointment to important administrative positions. The case in point was that in which the city of Little Rock had brought an action to force the water company to develop a new supply. The court, for whose judgment and courage the Engineering Record feels a great respect, realizing the difficulties experienced by the average lawyer in grasping technical facts, appointed not a lawyer but an engineer—Edward Flad, of St. Louis—as master in chancery. The decision was duly rendered ond confirmed by the court. Neither party contested the findings, which while not requiring the particular new reservoir demanded by the city does require the construction of additions, and also sets up certain standards for the quality of the water. It is needless to say that the satisfactory settlement of the case indicates that the confidence of the court in appointing an engineer was not misplaced. It would be in the interest of equity if other jurists would, in matters involving such technical questions, follow the lead of their Arkansas brother.

Unusual Municipal Report

THOROUGH studies of proposed large engineering enterprises, both public and private, are now the rule, though on smaller works, especially for municipalities, their absence entails frequent and sizable losses. As a result excellent reports are to be expected on large undertakings. Nevertheless, both the matter and form of the report on Philadelphia's rapid-transit scheme are so unusual as to warrant special mention. The system contemplated would involve an expenditure of $57,000,000, with a recommended initial construction or more than 59 miles of track. The report includes a large amount of accurate statistical data. The arrangement is simple and convenient, the analysis and conclusions are convincing. The final designs and recommendations are reinforced by elaborate estimates of cost, appreciation, earnings and expenses, presented so as to appeal to both technical and lay readers. Such a report is of great value to the municipality, for its findings form a bulwark against petty political attack. The report is somewhat unique in presenting an estimate of the money value of the time to be saved by prospective passengers—an amount equal in one year to more than half the total cost of the lines. It was considered that the most important factor in the system was the saving of time, and data were, therefore, prepared from which it was calculated, rather than estimated, that the time saving from various districts to the main business center varied from six to twenty-four minutes. With this as a basis, the money value of the time saved was computed. An elaborate investigation of electric and steam railroads in Philadelphia and other large American cities was made, and comparisons are presented by colored maps and diagrams which show the volume and distribution of traffic in different sections of the city. These, with other colored maps showing the density of population and the time saving from different zones, afford a very easy and graphic comparison of the principal considerations involved in the rapid-transit problem.

Correspondence Courses in Engineering

"UNIVERSITY extension represents the recognition of an educational responsibility extending beyond the confines of a college campus and offers the service of the university to the people of the State in every line of educational endeavor for which it is the best fitted instrument." Such is the view with which Professor Norris prefaces the article on page 280, in which he explains what the University of Wisconsin is doing to give instruction in engineering to those who are unable to give up their occupations and go to Madison. That the work is filling a real need seems to be shown by the fact that about 6200 men and boys have received technical instruction through this service and that it has been necessary to establish some seventy courses to meet the demands. While extension work is not new, such methods in engineering are of especial importance, in view of the needs of industry to-day. Employers generally are dissatisfied with the class of help they are receiving, and the continuation and corporation school movements are evidences of a determination to secure more competent employees. While the continuation school is directed mainly at the lower grades, corporation schools quite as often train men and women for the higher as for the lower positions. University extension instruction, then, is on a par with the work of the corporation school, and it is not surprising, therefore, to learn that the employers are co-operating by equipping classrooms for the extension students and allowing the instruction to be given on company time. Any scheme that will help to raise the personnel of industrial organization deserves hearty encouragement, and engineers will, therefore, wish godspeed to the efforts being made in Wisconsin. Naturally, and very properly, the scheme is being tried elsewhere, and we may in the near future expect to see many institutions engaged in the work. Their success will depend in a very large measure upon their ability to make the theoretical studies fit in with the practical applications being made daily by the students.

Timber Resources of the States

FOR some time past the U. S. Forest Service has been co-operating with various States in a study of their timber resources. Reports on some of the work have been issued and may be characterized as attempts on the part of the States to "find themselves," so far as their timber resources and uses are concerned. The documents are marked by the thoroughness characteristic of Government work. As might have been predicted, many interesting situations were discovered. Importation of woods from adjacent or distant States, when equally as good or even better supplies were at hand, undeveloped, was found to be rather common, while in other cases opportunities were pointed out for the expansion of old or the development of new industries because of the timber available.

Just what effect these reports will have on industries dependent on timber in the States studied is difficult to predict. Manifestly the apparent availability of timber of a certain kind will not of itself induce users of that timber to buy at home. Favorable lumbering conditions elsewhere may enable them to buy at lower figures than local producers can quote. Location of the timber, scale of production, labor markets, relative aggressiveness and ability of management and many similar factors enter the fixing of prices. Nevertheless, the first requisite for any progress is a clear comprehension of the facts. If they indicate desirable changes in trade relations or new ventures that are likely to be commercially profitable, there is certainly possibility of improvement, where previously ignorance had prevented it. Educational work among wood producers and wood consumers, based on these reports, is highly desirable, for, no matter how valuable the documents, experience has shown that the idea must be "sold" even to those sure to be benefited.

Load Factors in Hydroelectric Installations

THE percentage of utilization determines largely the unit cost of any factor in production. A plant once built has standing against it a fixed charge of investment and depreciation which cannot be dodged by any art of the bookkeeper, and this must be in some way or another distributed over the product. It is this factor which gives rise to the characteristic American principle of keeping the machinery rushed all the time. There is, of course, a wear-and-tear charge which is proportional to the output, but this is generally swamped in the fixed charges, since, as a matter of experience, the depreciation charge on machinery is usually due more to change in the art than to wearing out. In fact, if the charge due to obsolescence were small it would bespeak cessation of improvements.

In passing, it is worth noting that in certain lines of work a vicious system of selling has a most serious effect on the load factor of the plant as a whole. It is perfectly true that building the product only upon definite orders lessens the fixed charges levied in the form of interest upon the materials used; but such a scheme does not decrease the labor cost, in fact may actually increase it; nor does it favorably affect the fixed charges here considered; on the contrary, it is most unfavorable. Such considerations are quite general and may apply to any form of production.

The case here specially to be taken up is that of the hydroelectric power plant, now so important a factor in industry. Here there is an investment accompanied by what is substantially a fixed labor charge, so far, at least, as the main transmission is concerned. What shall be the policy of distribution to give the best total return? Obviously the first thing is to get load, and the chief items in load are well known from experience. They tend to give a total load, with an afternoon peak at or near 5 p. m., in which lighting and ordinary motor loads coalesce. It may happen that they rise to a combined value which fully takes up the available capacity of the plant. Then one of three things must occur—either further acquisition of load must cease, leaving the fixed costs to be laid upon the existing consumers as nearly pro rata as possible; additions must be taken on at the cost of auxiliary plant, or, finally, load must be found which will increase the total daily output without increasing the maximum peak. Clearly the last process is the one which tends most toward lessened fixed and labor charges and so gives the best outlook for returns.

This note is chiefly for the purpose of calling attention to the efforts that may be made toward building up the average load. If at the start load working over the whole twenty-four hours can be secured, good and well, for it reduces the gaps to be filled, but, besides this, specialized load during off-the-peak hours should be sought. Here comes a variety of forms of utilization—pumping load for city waterworks or irrigation; artificial ice plants, which need not run on the peak; storage battery charging, which comes mainly in the evening, and heating and cooking load, which comes chiefly in the morning and in the afternoon subsequent to the peak. Wherever load can be taken entirely off the peak it pays to make concessions in price to get it. If the hours of lighting of a city street-lamp load could be shifted even twenty minutes to dodge the extreme peak for a few weeks per year it might pay to make a reduction. In fact, wherever and whenever load can be removed from the peak it is worth a special effort. This is the policy of many a plant, but it is seldom pushed far enough and, moreover, can often be pushed much further than at first sight seems possible.

Stock-Keeping as an Engineering Problem

IN the operation of industrial plants, public utilities and municipal departments the work of the stores department is receiving well-merited and increasing attention from progressive officials. The importance of reducing the investment in supplies and reserve equipment to the minimum consistent with good service is now generally recognized, but the value of engineering judgment in dealing with this problem should be more widely appreciated. Stock-keeping in any technical industry is really a task demanding fairly expert supervision, and the responsibility of limiting the quantities and distribution of supplies in various localities is a good deal of a burden. Students of scientific management and engineers practising in this field turn to the stock department by instinct in the pursuit of economical methods and fair chances to try them out; but in many cases the machinery of such a department is perfected without giving sufficient attention to the consumption of material and apparatus for whose efficient handling the department exists. How important adequate stock-keeping standards and records are and to what extent efficiency in these particulars is bound up with efficiency in purchasing and use were made clear in the report of Elihu C. Church on the Bureau of Supplies of the Department of Water Supply, Gas and Electricity of New York, extracts from which were printed in this journal Jan. 3, 10, 17 and 24.

In many organizations the purchasing department is expected, theoretically at least, to scrutinize the work of the stock department to the extent of checking the quantities of material required from time to time and of keeping in general touch with the amounts of stock used at various operating centers. Without engineering assistance the most effective supervision of stock-department practice cannot be had, and the opportunities for co-operation here are constantly increasing. The relation of the engineer to the problem of stock-keeping is nowhere better illustrated than in the telephone field, where the multiplicity of supplies required, their extremely technical nature, and their relation to operating contingencies call for highly specialized ability in the conduct of stores, their distribution and their retention in or withdrawal from service. Either the engineer or the executive officer with engineering knowledge must study these questions if the operating organization is to steer safely between the Scylla of excessive investment and the Charybdis of an inadequate stock supply. Upon the engineer must finally rest the responsibility for deciding where emergency supplies are to be maintained, and in what variety and quantities, as well as for the safe amounts of routine material to be kept on hand at local points. It is obvious that it would be poor economy to have emergency supplies at every operating center, because it is unlikely that every such place will have emergencies to meet, and by centralizing supplies less can be carried with reasonable safety to the system as a whole than where efforts are made to maintain the existing quality of service by heavy local stocks. The same conditions apply to stock departments in manufacturing establishments having scattered plants.

These lines of work are likely to receive more thorough study in the future as the campaign for expense reduction grows apace. There may be as much opportunity for saving money through the engineering supervision of stock and reserve apparatus as there is in the study of losses in many steps in direct production. Thus, the proper treatment of material withdrawn from service on account of the consolidation of plants is a matter for the engineer to consider, from the dual point of view of the company or the municipality and the public. Material so removed is often of value for subsequent use by the same concern and can be saved for such use if it is inspected under engineering authority. In a public utility, moreover, such a withdrawal does not in any way increase the burden laid upon the consumer. At the time of the consolidation of plants the consumer may be properly paying a return upon the entire amount of property outstanding. The merging of the plants at a depreciated value may be a benefit to the public, and in such cases the removal of the duplicating material from the plant account and the transferring of its value to the supply account may not in any way increase the total value upon which the public at the time of the consolidation is obliged to pay a return. It is the function of the engineer to see to it that the increase in the supply account is counterbalanced whenever possible by a corresponding decrease in the plant account; that the condition is temporary and not in any way due to the overpurchase of supplies. Sound technical judgment is essential to the maintenance of complex service at the lowest cost consistent with reliability and economy of operation, and in the analysis of stock conditions by engineering forces can be found ample scope for exhaustive investigation and notable savings in investment.

Plan for a National University

GEORGE WASHINGTON was the first, or one of the first, proponents of a national university, and following him no less than ten presidents endorsed the idea. Now again the matter has been brought up in a bill introduced in the House of Representatives by Congressman Fess, himself a college president. The importance of the subject and its possible influence upon the work of the government, if properly directed, warrant consideration of the plan in the minds of the backers of the present measure and of an alternative scheme recently suggested.

It is pertinent to remark that the failure of Congress to enact a measure for the establishment of a national university is a clear indication that that body has felt for more than a hundred years that there is no demand upon the part of the Nation for such an institution, notwithstanding its advocacy by eminent men. Several times bills have been introduced, but have not prevailed. While apathy would probably be the reason assigned for the failure by the backers of the present measure, it cannot be denied that the advocates of the national institution have failed to show that there is any pressing need for the university or that private institutions cannot as well carry on the work.

The National Association of State Universities, composed of the presidents of the Land Grant colleges, is primarily responsible for the Fess bill. The presidents favor a purely post-graduate school, devoted to all manner of advanced investigation. Upon careful examination there can be little said in support of such a proposal, other than to grow eloquent and dilate upon the proper capping of "our grand educational system"—which, by the way, is the main line of argument of the backers. The need, however, is not so much for more research institutions as for men to do research work. The Carnegie Institution of Washington, founded to do the very work planned for the national university, has had difficulty in getting enough competent men to do the work it has planned. Furthermore, if one doubts that competent original investigators are difficult to find, let him examine the catalogue work—it is nothing better—accepted for master's and even doctor's degrees in science in some of the large Eastern privately endowed universities. But original thinkers are scarce and graduate schools must be built up. It is clear to one who has looked into the subject that, so far as research is concerned facilities are greater than the supply of men able to take advantage of them.

Recently a new plan for a national university has been proposed, and would be feasible under one of the sections of the Fess bill. This idea, following the plan of engineering education so successfully worked out by Dean Herman Schneider at the University of Cincinnati, calls for the establishment of a great training school for Government employees, working co-operatively with the departments in Washington. A student would spend half his time in theoretical studies in the university and half in the department for which he is being trained.

The advantages of the scheme are evident. It would increase the efficiency of Government departments and would give Government service here the standing it has abroad—on a par with that of the army and the navy. Furthermore, there is a very direct need for such training—a justification for the voting of Federal moneys which will readily be appreciated by the public and Congress alike. That could not be said of the research-institution scheme.

One instance may be cited to show the possibilities of such an institution. It is well known that the efficiency of the German consular service in South America is responsible for that nation's remarkable commercial progress there and our own lack of success. But the German consul in South America is of a type quite different from the vote-controlling, politically influential—though estimable—gentleman who represents the United States. The German consul is chosen because of his preparedness, not his political qualifications. If he goes to Brazil he knows, first, the language of the country, Portuguese, besides French, English and Spanish. He knows the country's political and commercial history, its products, its trade relations with the rest of the world, its banking system; he knows what foreign nations and foreign firms have interests there and what their affiliations with each of the important Brazilian firms and banks are. With this preparation he is more than a match for the representative of any other country—and trade statistics show that he is producing better results than his rivals.

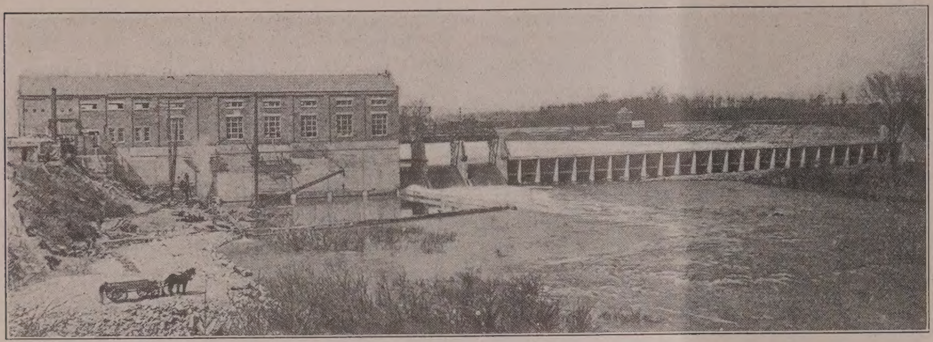
At a national university organized on the co-operative plan there would be taught the languages, economics, commercial and political history, etc., while service in the departments concerned with foreign trade and relations would not only give experience in the actual problems coming before those departments, but would familiarize the student with the machinery with which he will have to deal when in a foreign land.

It is not difficult to see the advantages that would accrue from this arrangement. Experience with practical problems fixes the classroom work in the memory and indicates the sort of collegiate instruction needed to elucidate practice. Objection will be made that the departments cannot afford to take the time to educate these men. That objection can be conclusively answered by consulting manufacturers, contractors, railroads and other corporations and agencies which have worked in conjunction with the engineering department of the University of Cincinnati. The objection exists only in the minds of those who have not looked into the subject.

The consular service, naturally, is but one to which the work of the national university would apply. The Treasury Department, the Department of Labor and all of the scientific bureaus of the Government would profit by such a scheme beyond possibility of present reckoning.

The Fess bill, however, should be rewritten, if this plan is adopted, so as to make the training of Government officials, and not research, the primary object of the university. Even then, of course, there would be considerable research work done, for the problems of the Government, and especially those of a scientific character, demand much original study. Moreover, the limitation that co-operation shall extend only to the scientific departments, as provided in the present bill, should be removed. Finally, the requirement for admission should be the bachelor's, not the master's degree.

The Engineering Record hopes that the co-operative plan will be strongly supported. It is the only proposal since the civil service law was enacted which holds promise of putting our Government service where it belongs—on merit solely and on a par with that of foreign Governments. Until it is so placed we cannot expect the efficiency governmentally on which the Europeans justly pride themselves.



Downstream View of Auglaize Power Development No. 1

Auglaize Power Development No. 1

First Plant of a Series of Four Low-Head Water Powers Ultimately to Generate from 28,000 to 30,000 Kilowatts

By REGINALD TRAUTSCHOLD, M.E.
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FOR the hydroelectric developments along the Auglaize and Maumee Rivers, which eventually will consist of four plants augmented by an auxiliary steam-power station, and which will develop from 28,000 to 30,000 kw, certain special features and unusual schemes have been planned to utilize the flow of a fluctuating stream to supply maximum power to a territory within a radius of from 60 to 75 miles. This territory includes the cities of Defiance, Napoleon, Toledo, Lima and Findley, Ohio, with numerous smaller intervening towns, and the city of Fort Wayne, Ind.—a market that is estimated to require several times the power of the completed development.

FLOW OF RIVER

The first of the available hydraulic powers (Auglaize 1) has been completed. It is located on the Auglaize River, near its junction with the Maumee River, about 4 miles above Defiance, the nearest railroad station. At the beginning Auglaize 1 will be considered as an individual installation; later its importance and value as affected by subsequent progress in the development will be considered. River studies during the last twenty years at the site of Auglaize 1—above which point the drainage basin is about 2800 sq. miles—show a variation between 45,000 sec.-ft. as the maximum and 500 sec.-ft. as the minimum. Both limits of this fluctuation were nearly approached during the year 1905, and the flood conditions were not again equaled until the disastrous floods of March, 1913. The year 1905 was taken as typical of the worst conditions for the development of power at Auglaize 1, and it was, therefore, used as the basis for all calculations. A fluctuation between 45,000 and 500 sec.-ft. is a range that does not promise very attractive conditions for an efficient installation. During the major part of each year, however, there is sufficient water to generate 5,000 kw or more, the mean effective head being about 26 ft. At no time is the capacity of the plant reduced below 1800 kw through excessive flowage—due to spring floods. On the other hand, periods of low water may reduce the flow of the river to such an extent that only about 850 kw could be generated, even when depending upon the pondage above the dam, which is from 2000 to 3000 acre-ft. To overcome this drawback advantage is taken of local conditions to augment the supply.

Practically the whole length of the Auglaize River and that of the Maumee River, after it is joined by the Auglaize, is skirted by the Miami River and Erie canal, which connects Cincinnati on the Ohio River with Toledo at Lake Erie, the canal crossing a tributary of the Auglaize River at Spencerville, about 60 miles above the dam site of Auglaize 1. This canal, which is not used for navigation purposes at this section, is fed from the Grand reservoir, about 18 miles above Spencerville, which has a capacity of about 136,000 acre-ft., and from the Loramie reservoir, 15 miles further up the canal, with a storage capacity of approximately 15,000 acre-ft. The Auglaize Power Company has leased from the State of Ohio that section of the Miami and Erie canal lying north of and including the surplus water of the Grand reservoir, and diverts this water storage to the tributary of the Auglaize River at Spencerville, thus increasing the river discharge during periods of low water when the power capacity of the stream is not affected by low-water conditions. The storage in the Grand reservoir is also adequate for raising the primary power capacity of Auglaize 2 (to be constructed on the Auglaize River about 16 miles above Auglaize 1) to that limited by flood conditions.

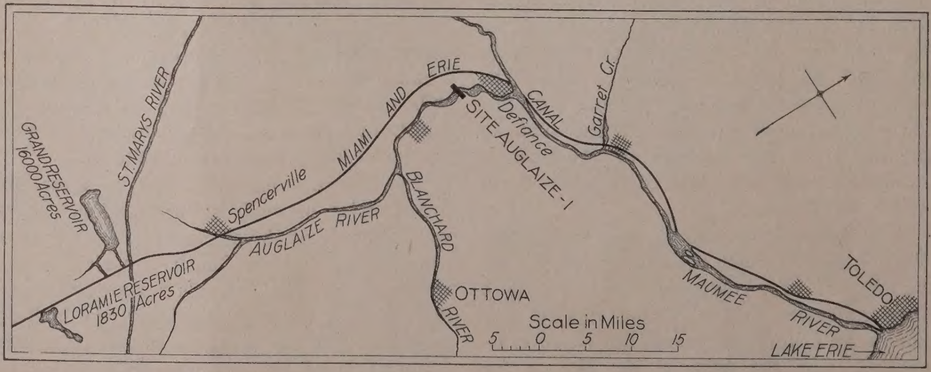
Auglaize 3 will also benefit from this storage, while Auglaize 4 will be built on the Maumee River to take care of the secondary power market, a large demand for occasional power supply existing in this district. At the present time the secondary power supply of Auglaize 1 can be increased and kept constant for a longer time by drawing from the Grand reservoir, but subsequent development will necessitate the husbanding of all such storage for primary power use, hence the proposed construction of Auglaize 4.

The bed of the Auglaize River consists of hard lime rock, 60 ft. thick in many sections, presenting unusually advantageous conditions for dam construction. The banks rise rather steeply, so that no great damage to the surrounding country is caused by impounded water. This pondage is not large, being about 2000 or 3000 acre-ft., but it is sufficient to increase the output of the plant during the short periods of extremely low stream discharge.

PRECIPITATION

The precipitation in this region, though fairly uniform so far as yearly rainfall is concerned, shows considerable variation from month to month, although it is usually excessive for a few days each year. This explains the great variation in stream flow, as the drainage basin of the river is uniformly underlaid with hard lime rock. Supplementing the stream flow with water from the Grand reservoir improved the low-water capacity of the plant, but, of course, it cannot assist in bettering the output of the station during the periods of excessive discharges.

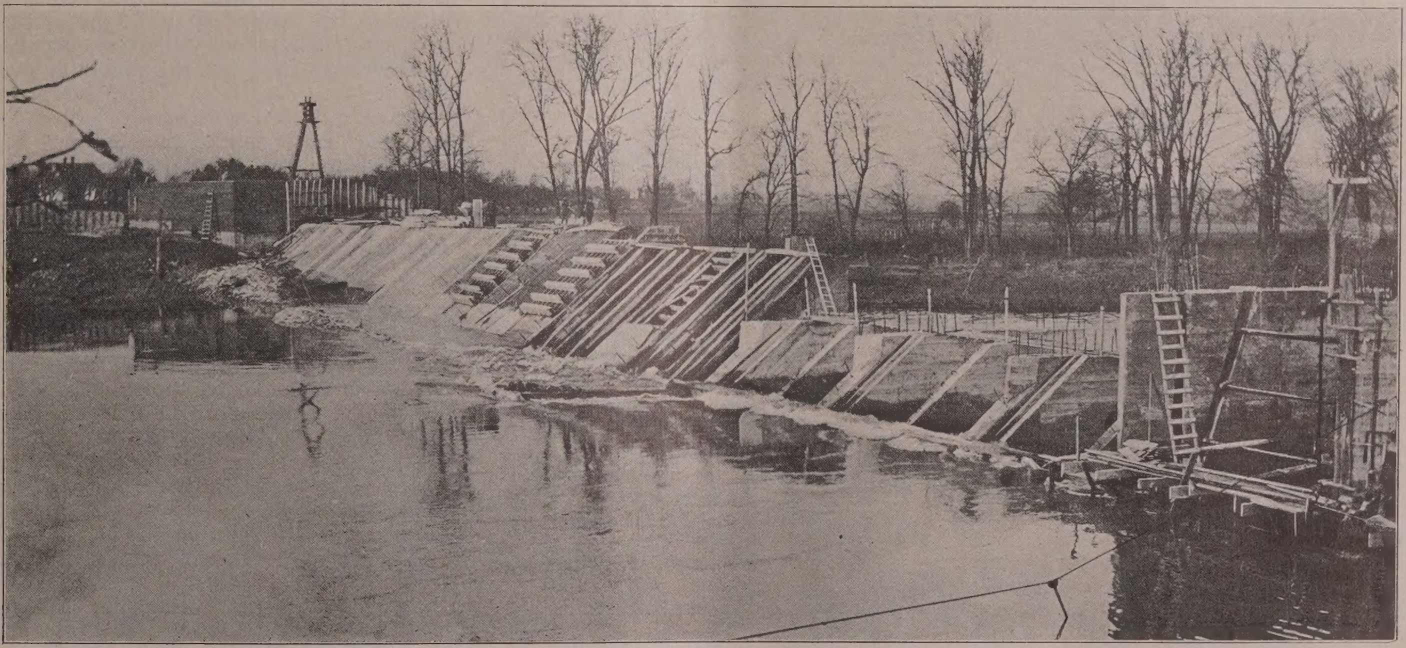
As the supplementary power capacity is sufficient to add about 1,622,400 hp hours to that of the stream during a year of least advantageous flow, and as this is more than that required to raise the capacity of the plant to 1800 hp constant power (primary power) for twelve hours each day—the limit placed on the capacity of the plant by the possibility of a year of very excessive flood conditions—the twelve-hour primary power capacity of the station is fixed at 1800 hp (1350 kw). For twenty-four-hour primary power, on the other hand, the supplementary water obtained from the Grand reservoir is not sufficient to raise the constant-power output of the plant to that limited by high-water conditions, 1800 hp, but only to 1220 hp (915 kw). For a considerable portion of the year, however, the hydraulic power possibilities of the stream are far in excess of that required for primary power purposes, 7,062,800 hp.-hours (5,297,100 kw-hours) for twelve-hour power service, and 10,109,400 hp-hours (7,582,050 kw-hours) for twenty-four-hour power service, figured on the year of lowest-known flowage, being available for secondary power purposes. At times this secondary power capacity of the plant is large, being 2750 hp (2,062.5 kw) for twelve-hour service and 3330 hp (2,497.5 kw) for twenty-four-hour service. The hydraulic-power capacity of the station, counting both primary and secondary power capacities, as now built, is 4550 hp (3412.5 kw) for constant and intermittent demand.



Plan Showing the Location of Auglaize Power Development No. 1

TABLE 1—POWER CAPACITY, YEAR 1905

	Hp-hours	Kw-hours
Twelve-Hour Power		
Primary power, 1800 hp. (1350 kw) continuously.—		
Hydraulic { Stream	6,991,380	5,243,535
Hydraulic { Reservoir	892,620	669,465
	7,884,000	5,913,000
Secondary power, 2750 hp (2,062.5 kw) maximum.— Hydraulic	7,062,800	5,297,100
Twenty-four-Hour Power		
Primary power, 1220 hp (915 kw) continuously.—		
Hydraulic { Stream	9,064,800	6,798,600
Hydraulic { Reservoir	1,622,400	1,216,800
	10,687,200	8,015,400
Secondary power, 3,330 hp (2,497.5 kw) maximum.— Hydraulic	10,109,400	7,582,050



Dam during Construction—Looking Downstream; Lower Section to Be Fitted with Tainter Gates

Auglaize 1 is a typical low-head hydraulic-power installation. The dam proper is of the reinforced-concrete hollow type, 375 ft. long, flanked at one end by three Tainter gates, 30 ft. wide. The generating room of the power house, approximately 150 ft. in length, is built in line with the dam, making the total length of the structure about 650 ft. The width of the pond at the dam crest is about 600 ft. Under ordinary conditions of stream flow the effective head is 26 ft.

MECHANICAL EQUIPMENT

Five 1500 hp, vertical single-runner waterwheels, 9 ft. in diameter, running at a normal speed of 94 r. p. m., are directly connected to 1000 kw, twenty-five-cycle, three-phase, 2300-volt generators. The rotating parts of the units are suspended from bearings on top of the machines and are provided with three guide bearings for keeping the main shaft in alignment. The thrust bearings run in water-cooled oil baths. The intakes to the waterwheels are protected by the usual trash racks supplemented by a floating boom, by which débris and ice are deflected to the Tainter-gate openings.

Eleven head gates admit water to the wheels, two for each main unit and one for the 250-hp exciter. These eleven gates are raised by a traveling 4.5 hp hoist running on tracks in the gate house. In addition to the water-driven exciter there are two other exciters, of 75 and 125 kw respectively, that are driven by 25-cycle, 2300-volt induction motors. These motor-driven exciters are to be used when water conditions necessitate the conserving of the available supply.

AUXILIARY EQUIPMENT

A comprehensive oiling system, installed in duplicate, is driven by 40-hp, twenty-five-cycle, 220-volt motors for supplying oil under pressure. Water pumps, also installed in duplicate, furnish water at 40 lb. pressure to the generator bearings. Low-pressure steam boilers are employed to heat the station and the adjacent homes of the station operators in winter. The steam may also, in the event of the disablement of the generating equipment of the station, be used to drive a 30-hp engine, which may be belted to a 22-kw direct-current generator for furnishing current for lighting and other purposes.

Five three-phase transformers are installed for the transmission line to Maumee and Toledo, stepping up the voltage from 2300 to 60,000 volts. The current for the transmission line to Defiance is supplied through three single-phase transformers delivering the current at twenty-five-cycle, three-phase, 13,000 volts, while the supply required by the station and outlying buildings is supplied from three single-phase, 25 kw, 2300/220/110 volt transformers.

The design and construction of the dam, power-house building and all the ground work were undertaken by the Ambursen Hydraulic Construction Company, while the hydraulic equipment and much of the electrical equipment were furnished by the Allis-Chalmers Company. The General Electric Company furnished switchboards and transformers. The design and construction of the power station were under the personal charge of R. R. Livingston, consulting engineer of New York City.

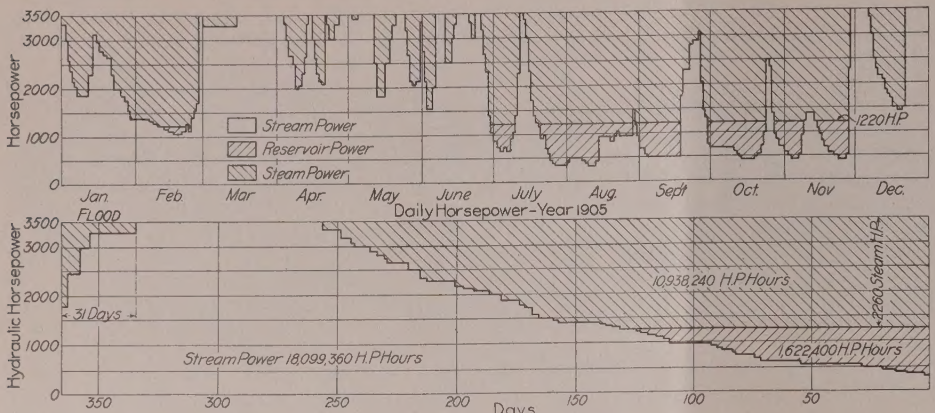
The main interest in this development does not lie in the present station, Auglaize 1, but in future developments. These consist of the building of an auxiliary steam-power plant and the construction of the second hydraulic-power station, to be known as Auglaize 2. The construction of an auxiliary steam-power plant will greatly enhance the value of Auglaize 1 and go far toward realizing the full benefits that the undertaking promised and which are assured if the plans of development are carried out.

The steam-power plant, to be erected either at Defiance or Maumee, is to be built with an initial equipment installation for the generation of 3000 kw, and provision has been made for the installation, as progress in the completion of the entire development project warrants, of two additional units of 5000 kw each. An initial installation of 3000 kw would enable the twelve-hour primary power output of Auglaise 1 to be increased to 4000 hp (3000 kw) by the development by the steam plant of 3,277,600 hp-hours—the capacity output of the auxiliary steam-power plant for but about sixty-eight twelve-hour days—and the twenty-four-hour primary power output to be increased to 3500 hp (2625 kw) by the development of 10,938,240 hp-hours by the steam plant—its capacity output for one hundred and thirty twenty-four-hour days—or increased to 4000 hp (3000 kw) by the development of 14,671,680 hp-hours by the steam plant—its capacity output for less than two hundred days.

Such increase in primary output of Auglaize 1 would, of course, nearly wipe out its secondary power capacity, but not

TABLE 2—POWER CAPACITY WITH STEAM AUXILIARY, YEAR 1905

	Hp-hours	Kw-hours
Twelve-Hour Power		
Primary power, 4000 hp (3000 kw) continuously.—		
Hydraulic { Stream	12,620,000	9,465,000
Hydraulic { Reservoir	1,622,400	1,216,800
Steam auxiliary	3,277,600	2,458,200
	17,520,000	13,140,000
Secondary power, 550 hp (412.5 kw) maximum.— Hydraulic	904,400	678,300
Twenty-four-Hour Power		
Primary power, 3,500 hp (2,625 kw) continuously.—		
Hydraulic { Stream	18,099,360	13,575,320
Hydraulic { Reservoir	1,622,400	1,216,800
Steam Auxiliary	10,938,240	8,202,880
	30,660,000	22,995,000
Secondary power, 1,050 hp (787.5 kw) maximum.— Hydraulic	1,093,840	820,380
Twenty-four-Hour Power		
Primary Power, 4000 hp (3000 kw) continuously.—		
Hydraulic { Stream	18,745,920	14,059,440
Hydraulic { Reservoir	1,622,400	1,216,800
Steam Auxiliary	14,671,680	11,003,760
	35,040,000	26,280,000
Secondary power, 550 hp (412.5 kw) maximum.— Hydraulic	438,280	328,710



Available Primary Power for 3500-Horsepower and 24-Hour Service

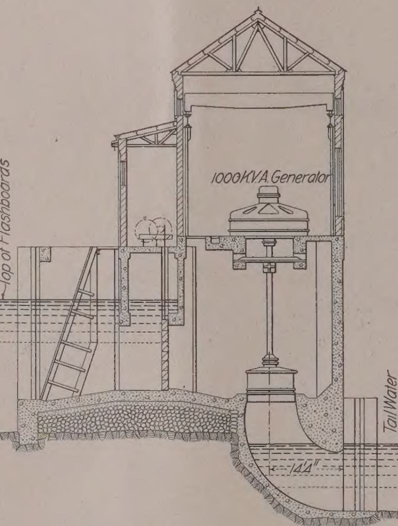
entirely; 904,400 hp-hour (550 hp, or 412.5 kw maximum) could still be counted upon for twelve-hour service and 1,093,840 hp-hours (1,050 hp or 787.5 kw maximum) for twenty-four-hour power service with a primary output of 3500 hp (2625 kw), or 438,280 hp-hours (550 hp or 412.5 kw maximum) for twenty-four-hour power service with a primary power output of 4000 hp (3000 kw).

MARKETING OF POWER.

The output of Auglaize 1 has been contracted for at prices that promise a fair profit on its cost of construction, whether the market should be for twelve-hour power or for twenty-four-hour power. In reality the market is neither for all twelve-hour nor for continuous power, so that the net returns of the station lie between the two amounts. A comparison of Tables 1 and 2, the latter showing the output of plant augmented by auxiliary steam power, indicates that the best returns obtainable from the investment already made are not yet being realized.

Table 2 gives the steam-power requirements necessary to raise the primary power output of the station to 3500 hp and 4000 hp respectively. The initial installation of the steam-power plant—3000 kw—is ample for either of these increases, and also to similarly augment the power output of the second hydraulic station. The investment necessary for the construction of a steam plant of 3000-kw capacity, providing for its future enlargement to 13,000 kw, would be about 21½ per cent of that already made in the development of the undertaking. This would increase the fixed charges of Auglaize 1 by about 31 per cent. Operating the steam plant for twelve-hour-power service would entail an annual expenditure for fuel of less than 12½ per cent of the present annual operating expenses of the hydraulic station, while operating the steam plant for twenty-four-hour-power service would mean an additional annual expenditure for fuel of about 40½ or 45½ per cent, depending upon whether the primary power output of the station was raised to 3500 hp or to 4000 hp. That is, the combined fixed charges and operating expenses for Auglaize 1 and the 3000-kw auxiliary steam-power plant would be, for twelve-hour power, about 43 per cent more than for Auglaize 1 alone; and for twenty-four-hour power, about 71 or 77 per cent more, depending upon whether the primary power output was increased to 3500 hp or to 4000 hp.

Should it be possible to dispose of the output of the two plants—Auglaize 1 and the steam auxiliary—as advantageously as the hydraulic power (and the market requirements give every indication that it could be done) the earning power of the present development would be greatly increased. The combined station with 3500-hp primary output would show for twelve-hour power an increased earning capacity of about 122 per cent and about 188 per cent for twenty-four hour operation for primary power, and a decreased earning capacity for secondary power of about 87 per cent for twelve-hour operation and of about 89 per cent for twenty-four hour operation. Operating the steam-power plant so as to increase the primary output of the combined station to 4000 hp would increase the earning capacity for twelve-hour-power operation similarly and for twenty-four-hour-power service nearly 228 per cent; the decrease in secondary-power earning capacity would be the same as in the lesser enlargement for twelve-hour service, and for twenty-four-hour service there would be practically no secondary power to dispose of.



Cross-Section of Power House

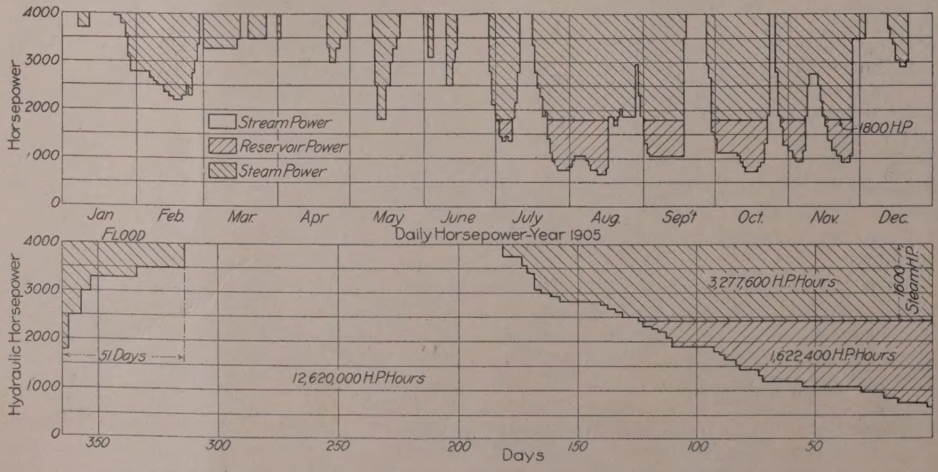
EARNING CAPACITY

The net earning capacity of the enlarged plant, provided its output can be disposed of at the same rate as that of Auglaize 1, will be increased by about 112½ per cent for twelve-hour power and by 310 per cent or 490 per cent for twenty-four-hour power, the former if the primary output be increased to 3500 hp and the latter if the constant power output of the combined station be increased to 4000 hp.

It would then seem that further investment in the way of immediate construction of a steam-power auxiliary plant to augment the power output of the present hydroelectric station is necessary, not only on account of the profit that would be realized but as a safeguard of the present investment and a guarantee of returns on both the money already invested and that required for the auxiliary steam power plant.

Experimental Sewage Testing Plant at Indianapolis

LATE in 1911 Indianapolis started working on her sewage-disposal problem. From the flow readings taken the amount is found to be approximately 44,000,000 gal. daily, of which a large portion is trade wastes. During the last year an experimental plant has been erected. Charles Brossmann, in a recent report to the Indiana Sanitary and Water Supply Association, gave a brief outline of the plant as follows: The Imhoff tank is of reinforced-concrete, 24 ft. in diameter and 33 ft. in depth. The rectangular settling chamber has a capacity of 2800 cu. ft. and that of the sludge chamber is 6300 cu. ft. Partitions of the settling chamber are of sheet steel. Two circular sprinkling filters of wood with concrete bottoms are 16 ft. in diameter and 10 ft. deep. Each tank is divided into quarters by wooden partitions. Different depths of stone ranging from 6 to 8 ft. are being tested. The filter effluent is brought back to the sewer. Electrolytic treatment of the tank effluent is also being studied. A fully equipped laboratory has been erected over the pumping outfit and electric cells.



Available Primary Power for 4000-Horsepower and 12-Hour Service

Contract Scandal in Philadelphia

Irregularities in Award and Execution of Concrete Work Disclosed in Committee Report by Allen Hazen, Richard L. Humphrey and Frederick W. Taylor

SCANDALOUS conditions in the award and execution of the contract for concrete work at League Island Park, Philadelphia, built under an agreement dated May 21, 1909, between the city of Philadelphia and Edwin H. Vare, are disclosed in the report of an investigating committee, consisting of Allen Hazen, Richard L. Humphrey and Frederick W. Taylor, which submitted its findings to Morris L. Cooke, director of the Department of Public Works, on Jan. 24. The committee was appointed primarily to examine and report upon the character of the concrete in walls and pavements along a lagoon in the island, an item for which the city had expended $277,727 under former municipal administrations. The committee finds that the work was badly designed, badly built and is now practically useless and that the course pursued in authorizing and carrying it out is that which would be expected if the main object were to create profitable work for a favored contractor. The concrete now in place will probably have to be removed before a satisfactory park can be made. Irregularities in preparing and advertising the contracts are charged and the scheme of inspection which required the contractor to pay the inspector who nominally protected the city's interests is characterized as of the worst type. A summary of the committee's findings and recommendations follows:

DEFECTIVE CONCRETE WALL

The largest item of the work under this contract upon which the committee's judgment was asked was a wall called a "light protection wall." This wall is built to surround the lagoon; it rests on piles, is 5 ft. high, from 2 to 3 ft. thick, and is surmounted by a rough stone top. The total amount paid for this wall was $213,054.60. A number of cuts were made in the wall to disclose the character of the concrete. It was found that about 1600 ft. of wall were of poor quality, not meeting the requirements of the specifications. The remainder, approximately 8080 ft., showed many defects, but considered broadly the concrete in it was sufficiently good.

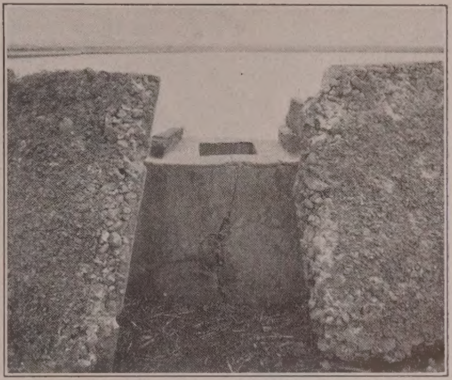
For the concrete the contractor used an unwashed gravel, fairly well-graded but full of impurities which tended to impair the quality of the concrete made from it. The gravel contained wood, lumps of clay, pieces of coal and some very fine material, part of which was organic matter. The presence of this foreign material accounts in part for the lack of coherence and hardness and poor surface in various parts of the work. The use of this gravel was not permitted by the specifications, which required that broken stone should be used. If the gravel had been properly washed and screened it would have been equal to the crushed stone specified. The specifications fixed the maximum dimension of the aggregate as 1½ in. There were found throughout the concrete pieces ranging from 4 to 5 in., and while the committee is of the opinion that for the mass concrete in the wall this was not objectionable, it was objectionable in the sidewalks where the base was only 4 in. thick.

In this defective concrete there are horizontal seams at points where there have been breaks in the construction of the wall, as at the end of the day's work; and the concrete was not composed of sufficiently good materials and not sufficiently mixed to be of a quality to resist frost action. As a result of these defects fissures have already been produced which disfigure the wall.

This wall should have been built in monolithic sections with only vertical joints. It was not built in this way. Horizontal joints were also made and it appears that the seams are largely the result of failure to remove the laitance and impurities of various kinds, and to the concentration of the fine materials resulting from the excessive working of a wet mixture, which produced a layer of mortar of slow hardening quality at the top of the concrete placed at one time, and possessing insufficient strength to resist frost action or to permit the proper bond or union with the concrete subsequently placed.

NO EXPANSION JOINTS

The plans and specifications, the committee finds, were defective in that there was no provision for joints for expansion and contraction of the concrete in setting and with changing temperatures. Notwithstanding this omission some joints were provided, but they proved to be inadequate, for many cracks have occurred at other points than the joints. The joints which were examined consisted of a layer of mortar averaging about 1 in. in thickness inclusive of tar paper and providing practically no compressive material. This paper had become hard and brittle and the joint was not effective.



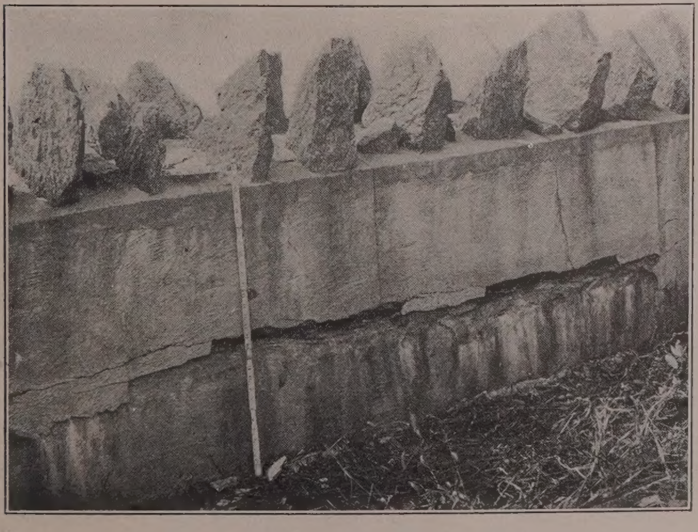
Large Size of Concrete Aggregate

The contract required the walls to be topped with granite. No granite was used; gneiss, a cheaper material, was substituted.

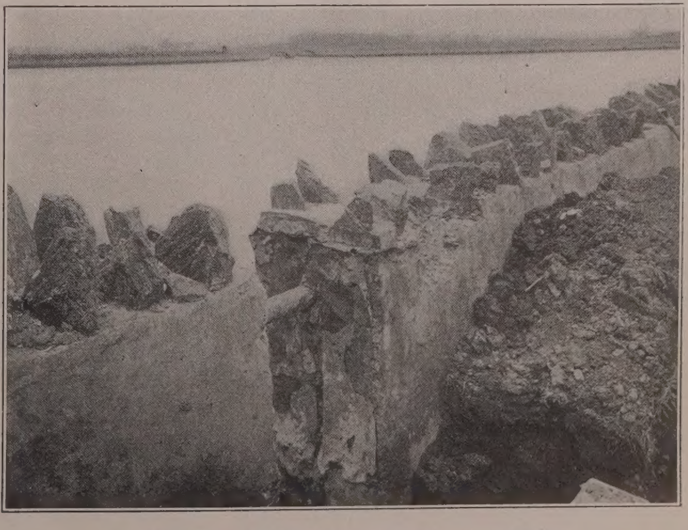
The timber substructure did not comply with the requirements of the specifications, which provide that the piles shall be at least 12 in. in diameter at the top where cut off. It was found that in every section examined one or more piles of the four piles exposed failed to meet this requirement. One of the piles was only 7⅜ in. in diameter.

SIDEWALKS

A concrete pavement surrounds the lagoon and runs around the wall on and through the island. In order to determine its thickness and general character slabs were removed and examined. The pavement generally has a width of 12 ft., made up of three rows of slabs each 4 ft. square. A surface examination was made of the slabs, 7604 in all; cracks, spalls or pitting of the surface were noted. These surface pits were due to the presence of pieces of wood, coal and clay contained in the sand and gravel used for making the concrete. These had subsequently rotted or oxidized, or been washed out, leaving voids and pits in their places. These formed ugly holes,



Fissures and Cracks in Lagoon Wall



Character of Inadequate Expansion Joint

often 1 in. or more across and ½-in. deep, and disfigured more than one-third of all the slabs in the pavement.

The surfaces of about 50 per cent. of the slabs examined are classified as good, that is, slabs with surfaces not seriously marred, but in no case did the committee find slabs that would represent first-class sidewalk construction, such as is readily obtainable for the price paid for this work. Eleven per cent of the slabs were cracked and 35 per cent were spalled.

The specifications require the slab to be 5½ in. thick, consisting of 4 in. of base and 1½ in. of granolithic mixture. No slab fulfilled these requirements. In all of the slabs the granolithic varies from ¾ to 2¾ in. and the base from 1 to 3½ in. The average of all measurements shows a thickness of granolithic mixture of 1.62 in. and of base of 2.55 in., making an average total thickness of 4.30 in. This is 22 per cent less than the 5½ in. required.

The sub-base under the 31 slabs examined was found to be ashes varying in thickness from 8 to 20.5 in., with an average of 14.4 in. The committee was unable to find any provision in the specifications for this sub-base. The ground is saturated with water and no provision had been made for drainage. Frost action on this material saturated with water has apparently caused much of the movement and cracking that exists and which disfigures the pavement.

The island in the lagoon is reached from the main land by three concrete bridges each about 15 ft. wide, having two spans of about 20 ft. each. They are examples of poor design and inferior workmanship, according to the committee. As they were built into the wall about the lagoon, without provision for expansion and contraction, the pressure resulting from the expansion of this wall has resulted in spalling and cracking of the concrete in places and this disfigures them. The inferior character of the gravel, above referred to, made it impossible to obtain a satisfactory surface finish.

ENGINEERING

The structures at League Island Park seem to have grown rather than to have been the result of definite design. For instance, it was impossible to find any design whatever for the bridges. The building of the so-called "light protection wall" on piles which are practically the equivalent of stilts, and without providing expansion joints in the long lengths of it and especially at sharp bends and where it connects with other structures, does not suggest that any engineer had to do with it. The specifications were loosely drawn, inconsistent and lacking in essential details, the committee states.

Conditions, the committee believes, never justified the construction of the wall, which is the principal item in the work, and it can serve no useful purpose. On the other hand, its presence is a serious handicap in the development of the park, and the greater part of it will have to be removed in order to provide the shallow water and beaches essential for a useful city park. The whole work and proceeding shows no sign of engineering control.

The specifications provide for inspection as follows: "Inspector. The Contractor will be required to employ at a monthly wage of $100 a month an inspector to be named by the Department of Public Safety, etc." This is a vicious provision which cannot be too strongly condemned. A city should provide its own inspectors. In this case the city, in undertaking work which costs hundreds of thousands of dollars, turned over the sole protection of its interests to a man employed and paid by the contractor. The fact that this man was nominated by an officer of the city afforded no protection as actual experience in this case fully demonstrates.

The manner of advertising for this work, which ultimately involved the expenditure of over one million dollars, amounts to a scandal. The advertisement appeared in fine print in six local papers. Only 9 days were allowed for the submission of bids. The proper interval would have been at least three or four times as long. The advertisement begins with a request for bids for the construction of police, fire and patrol stations, thus giving the impression that the advertisement covered relatively small work. Afterward in five lines the work at League Island Park is mentioned and this is followed by other matter. Nothing is said to give bidders an idea of the nature or the magnitude of the work. For all information, bidders are referred to the city forester, an individual unknown generally to contractors for work of this character. A deposit of 20 per cent of the amount of the bid was greatly in excess of that usually required and tended to discourage or prevent competition.

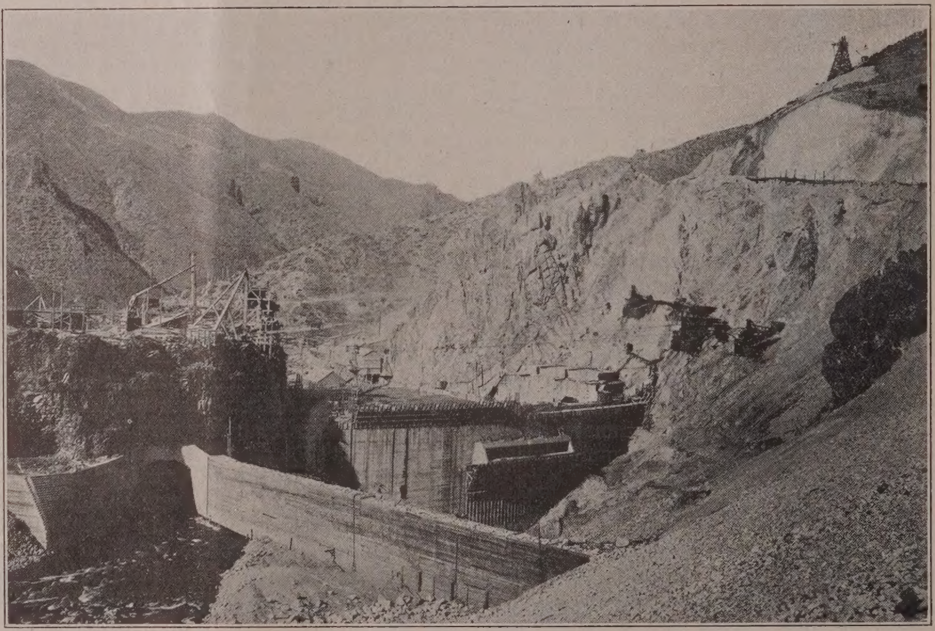
The contract covers much work in addition to the concrete work on which the committee reported. It was made for an original amount of $498,000 on May 21, 1909; it was afterward extended without inviting further bids and at the time work was stopped in February, 1912, there had already been paid to the contractor $995,123.24 or nearly twice the amount of the original contract.

THE Isvor tunnel in Roumania, on the Sinaya-Moreni line, is under contract, according to the Engineering Supplement of the London "Times." Julius Berger Tiefbau Aktiengesellschaft will build the tunnel, which will be 4 miles long, and is expected to cost about $2,500,000, and take twenty-eight months to build.

Progress on Arrowrock Dam

Concreting for 530,000-Cubic Yard Structure Was 35 Per Cent Complete on Jan 1, 1914

EXCAVATION was begun on the river-bed foundation of the Arrowrock dam in Idaho, forming a part of the Boise project of the U. S. Reclamation Service, in July, 1912, and was completed in August, 1913. The material excavated consisted of sand, gravel and boulders and totaled about 250,000 cu. yd. The excavation was done with a steam shovel and a dragline excavator, assisted by two electric cables. A steam shovel has also been in use on the spillway, and this was practically completed at the end of 1913, with a total excavation of 225,000 cu. yd.



Construction View of the Arrowrock Dam, U. S. Reclamation Service

The completed dam will contain approximately 530,000 cu. yd. of concrete. The work of concreting was begun on Nov. 11, 1912, and was confined to the building of a narrow section of sufficient height to act as a diversion dam in case of extreme floods. This first section was completed on April 17, 1913, with a total volume of 67,500 cu. yd.

On July 17, 1913, concreting was begun on the full section of the dam; and at the close of December, 1913, there had been placed 186,000 cu. yd. This is equivalent to about 35 per cent of the total volume of the dam. The main body of the dam is being built of rubble concrete. The concrete mixture consists of about 1 part sand cement, 2½ parts sand, 5 parts gravel, and 3 to 4 parts cobblestone.

A sand-cement plant is operated in connection with the work. The sand cement is composed of equal parts of Portland cement and pulverized granite ground in tube mills to such fineness that about 95 per cent will pass a 200-mesh sieve. The aggregates for the concrete are obtained from excavations for the foundation of the dam, which are removed by a dragline excavator and steam shovel, and conveyed to the mixing plant by electric cableways.

The foregoing statement of progress was prepared for the Engineering Record by F. W. Hanna, engineer of the U. S. Reclamation Service.

Handling Materials for Concrete Roads

Committee's Suggestions on Economic Methods of Dealing with Water and Aggregates

A COMPARISON of the best methods of directing the use of concrete-road materials is given in a report presented at the National Conference on Concrete-Road Building, held in Chicago, Feb. 12-14, by the committee on economic methods of handling and hauling materials for concrete roads. This committee included Halbert P. Gillette, editor in chief of "Engineering and Contracting"; Donald D. Price, State engineer of Nebraska, and Percy H. Wilson, secretary of the Association of Portland Cement Manufacturers. An abstract of the report follows.

Water, an element quite apt to be accorded scant consideration, is used for at least three purposes in building concrete roads—to wet the subgrade, to mix the concrete, and to keep the concrete moist for several days after it is laid. On a sandy subgrade that must be wet and rolled before laying the concrete, as much as 100 gal. per cubic yard of concrete may be used, merely to wet the subgrade. Then an additional 50 gal. or more will be required to mix the concrete wet enough to flow readily. Finally, as much as 80 gal. of concrete will be needed to keep the concrete wet for a week after it is laid, if the air is very dry and if there is much wind. A total of 230 gal. of water, weighing 1900 lb., has been required in one case for each cubic yard of concrete. More than that would have been used had the concrete not been kept covered with a layer of earth an inch or more thick.

A ton of water per cubic yard of concrete may probably be regarded as the maximum that need ever be required. A quarter of a ton of water per cubic yard is probably the minimum, if there is to be any sprinkling of the subgrade and of the concrete. A 2-mile haul at 25 cents per ton-mile results in a cost of 50 cents per cubic yard of concrete for hauling the water where the maximum amount is needed. This is astonishing indeed to the contractor who has been accustomed to mix and place concrete for 50 cents a cubic yard under certain conditions.

When large quantities of water are to be moved considerable distances pipe lines should usually be laid along the road and the water should be pumped. Quite a common mistake is to use pipe of such small diameter that the friction head makes it impossible to deliver the quantity of water needed. It should be remembered that the head against which the pump is acting is the sum of the static head and the friction head, and that the cylinder of a pump may be cracked under an excessive pressure thus developed.

CEMENT

In the handling of cement there are two very common economic errors—failure to provide a large stock and an attempt to locate the cement nearer the concrete mixer than is necessary. The concrete-road builder is so often forced to wait for the delivery of cement by rail that he eventually learns that it pays to tie up more capital in a stock of cement than to foot the bills incident to delays in securing it by rail. Although cement dealers are usually prompt in making shipments, the railways are not always to be relied upon. For this reason, cement should be accumulated in stock-houses or stock-tents. Tents, with wooden floors made in sections, can be placed at short intervals along the road. From them the cement can be delivered in small gasoline motor cars of the kind that cost about $500 each. Such a car will carry 10 or 12 bags of cement and can be run into the tent to be loaded by the driver of the car. The car will travel from 15 to 20 miles an hour loaded and 18 to 25 miles an hour empty, at a total cost of about 4 cents per car-mile one way or 8 cents per car-mile of effective hauling work. The committee recommends this practice as the most economical way of hauling cement short distances.

In practice, the body of a pleasure car is removed and a platform placed on the rear part of the chassis. The same method might be applied in hauling concrete from a mixer to the road. To do this, a concrete bucket would be mounted on the chassis and the concrete would be discharged from the bucket through a trough. It might be desirable, in using such a method, to provide a pair of trussed planks that would span the road and be used as a runway for the automobile.

SAND

After the subgrade has been sprinkled and compacted by rolling, it is customary to dump sand and gravel on it in piles. Then these materials are loaded into barrows and wheeled to the concrete mixer which travels along the subgrade, leaving the layer of "green" concrete behind. Although this is at present the most common way of placing concrete, there are some contractors who maintain that it is not the cheapest. Another method is to place both the mixer and the stock piles on one side of the road. The materials are then usually shoveled directly into the mixer, or into a bucket or skip, that delivers into the mixer. In the West it is not unusual to see Fresno scrapers used to drag the sand and gravel from the stock piles to the mixer. In some cases the scrapers deliver the materials upon a platform whence they are fed by gravity into a skip that delivers into the mixer. In these cases the mixer is not moved until about 600 to 1000 ft. of road have been built in both directions from the mixer, the concrete being hauled in one-horse concrete carts or in one-man concrete buggies. Local conditions will suggest the most advantageous method.

GRAVEL AND STONE

Although cement and even sand may be rehandled without adding greatly to the cost of a concrete road, an attempt should always be made to avoid rehandling the gravel or broken stone. Broken stone is particularly hard to shovel up when dumped on the ground, and, besides, it constitutes a very large part of all the materials to be handled. Stock piles of sand may often be needed to avoid delays in freight shipments, and in such cases they may be placed at relatively short intervals along the side of the road. If broken stone or gravel is also received by rail, it is generally wise to build the stock pile at the place where the cars are unloaded. Then a clamshell bucket can be used both to unload the cars into the pile and to load the wagons from the pile.

If large stock piles of stone or sand are to be made along the road, care should be taken to scrape a smooth place upon which to build the pile. With a road machine and a roller a place can be so graded and compacted that very little of the material in the stock pile will be lost. Care should be taken to locate such stock piles where heavy rains will not wash the materials away.

In the handling of broken stone from portable rock crushers, two economic errors are common—the bins are too small and their bottoms are not steep enough. Small bins make it necessary to stop the crusher if there is not perfect co-ordination in hauling and using the materials. Bottoms that are flatter than 1 to 1 prevent the stone from running rapidly, and thus delay the loading. This last is important enough with team-hauling, but it is much more important where motor trucks or traction engines are used.

HAULING BY POWER

Although the horse and the mule will long continue to be used on road work, their "day" for hauling road materials is fast passing. Motor trucks of 3 to 5-ton capacity are becoming popular for hauling wherever the roads are sufficiently good to admit their use. Recently the use of "trailers" has added much to the popularity of motor trucks. While a "trailer" decreases the speed of transportation it greatly increases the tonnage hauled each trip. Traction engines hauling trains of wagons have been in successful use for many years.

As to the relative economic merits of motor trucks and traction engines, no data yet available point either to the one or the other as being clearly preferable. In making comparisons, several things, other than the ton-mile cost while hauling during the road building season, should be kept in mind: Whether the hauling plant can be used for other purposes than road building; whether it can be used in the winter; whether it destroys existing roads and subgrades sufficiently to be objectionable; whether there is room to maneuver.

Not a few men are making it their sole business to contract for hauling. Such men often work their hauling plant two shifts daily, running about 18 hours out of the 24. This greatly reduces the interest cost per ton-mile. A not uncommon price is 15 cents per ton-mile over rough roads and under severe conditions.

U. S. Government Testing Flume Needed

Arguments Submitted to Boston Society of Civil Engineers by George F. Swain, Ira N. Hollis and Charles T. Main

THE following arguments in favor of a Government testing flume have been submitted to the Boston Society of Civil Engineers by three of its past presidents—George F. Swain, professor of civil engineering at Harvard University; Ira N. Hollis, president of Worcester Polytechnic Institute, and Charles T. Main, consulting engineer, of Boston. This committee requests that such action be taken in connection with the establishment of a testing flume as may be in accordance with the methods of the society.

Waterwheels have increased so much in size in recent years, and are operated under so much higher heads, that there is now no place in the United States where they can be adequately tested before their final installation.

The Holyoke testing flume, the only place of its kind in this country, has done more for the improvement in efficiency of waterwheel runners than can properly be estimated. The Holyoke flume, however, is no longer large enough, nor does it have sufficient head to meet all of the present-day needs. What the country really needs is a testing flume large enough to test properly not only the largest runners and their settings, but to provide for reasonable future requirements. The head on a flume of this kind should be variable up to at least 150 ft. The flume should be suitable for conducting on a large scale experiments in the various methods of measuring water under conditions found in actual operating plants. The art of waterwheel design is still in rather a crude state and needs such authentic and reliable information as the proposed flume will furnish.

Niagara Falls has been suggested as a proper place to establish such a testing flume, and, as a matter of fact, appears to be the only suitable place. It has the advantages of geographical location and of a relatively large supply of water; as the total amount of water used in a testing flume is a small item, there certainly could be no opposition from those interested in the conservation of Niagara Falls. The use of water would be intermittent and of comparatively short duration. The above-mentioned variable heads up to at least 150 ft. are obtainable at this point.

A flume of this kind would be used not only by waterwheel manufacturers, but would be of inestimable value in conserving the water-power resources of the country.

The Geological Survey is doing invaluable work in connection with studies of stream flow and control. Why should not the Government take up experiments in the efficient use of water? Water power that passes a plant unused or used inefficiently represents a sheer waste, and the prevention of this waste means a saving of just so much fuel.

The ordinary difference between loss of power from fuel and from water is that water power when wasted is irretrievable, while fuel not used is saved for future purposes. This means a double saving. Moreover, in contrast to most other Government experiment stations, the Niagara flume, by charging a reasonable fee for the testing, could probably be made nearly, if not entirely, self-supporting.

The only argument so far advanced against the establishment of a testing flume by the Government is the political one. Judging by past history, a hydraulic testing department might have the tendency to extend beyond the legitimate needs for which it was created, but if such a department were established its work could be kept within its natural field of activity. If the personnel of this department were wisely chosen there could be no doubt of its success.

THE term "civil engineer" will be defined by the Provincial Government of British Columbia if the efforts of the Victoria and Vancouver branches of the Canadian Society of Civil Engineers are successful. They have united in an effort to have the Government define the term as used in the Water Act now under discussion and have requested that the definition be that a civil engineer is a member of the Canadian Society of Civil Engineers, the Institution of Civil Engineers or of a similar organization "of equal standing." Reports state that the proposal will probably be adopted.

Repairing Montreal Water-Supply Conduit

Steel Pipe Section to Close Hole 60 Feet Long in a 9-Foot Reinforced-Concrete Low-Pressure Aqueduct

TEMPORARY repairs to the break in the Montreal water-supply conduit, which is described in detail in the report of the board of consulting engineers on page 277 of this issue, occupied eight days and involved the use of a section of steel pipe which penetrated the uninjured conduit at both ends. The spaces between the ends of the steel pipe and the conduit were filled with a concrete seal, which, as soon as the water was turned on, was partly washed out, necessitating a further delay for the replacement of the concrete and the construction of a wooden bulkhead to supplement it. The broken section of the conduit was removed and the foundations for the steel pipe were built with the aid of a large excavating machine. The steel-pipe section has been inclosed in a wooden shed to protect it from the severity of the winter weather.

The horseshoe-shape conduit, about 5½ x 7½ ft. inside, is 27,500 ft. long from the intake in the St. Lawrence River above the Lachine Rapids to the pumping station in Montreal. It has a grade of 1 in 5000, a capacity of 50,000,000 gal. per day and was subject to a pressure of 6 to 12-ft. head. At the point where it was broken it was built of concrete from 8 to 12 in. thick above the center line and lightly reinforced with Clinton wire cloth. At this point it had been exposed on one side by excavations alongside, made by a heavy excavating machine traveling and depositing spoil over the top of the conduit, and thus developing heavy stresses in the latter, as described in the report of the accident previously referred to.

The Conduit Break

The excavation opposite the broken portion of the conduit had been made by a 3-yd. bucket working down to a depth of 5 ft. below the bottom of the conduit and depositing 5 ft. of soil over the conduit at this place, thus increasing the depth of material above it to about 10 ft. About Dec. 18 leakage was observed coming through the canal pipe opposite the conduit, and in two days the material had been washed away to expose the side of the conduit. Efforts were made without much success to calk the cracks in the conduit with oakum. Wooden sheet piles were driven parallel to the conduit to form a cofferdam against which to brace the conduits; but on the afternoon of Dec. 25 the conduit burst, tearing out a hole 3½ ft. high and 60 ft. long on the lower side of the conduit next the excavation and scouring out a considerable amount of material under and around the conduit. The water supply was immediately shut off and the conduit allowed to empty.

Emergency repairs under the direction of George Janin, city engineer, were immediately commenced. A rush order for 125 lin. ft. of riveted steel pipe, 7 ft. in diameter, was placed with a local firm, the injured section of the conduit meanwhile being removed. A Bucyrus dragline excavator was available on the line of the adjacent canal aqueduct excavation, about 1000 ft. away from the break. Although the pumps were frozen so that it was necessary to fill its tank with water brought from the canal in pails, steam was made as soon as possible and the excavator was moved to the break. Here it served as a steam shovel and a derrick and operated a 3-yd. bucket which was filled with stone and swung against the concrete to break it, thus giving more satisfactory results than the first attempt to break up the concrete by mud capping with dynamite. It also excavated about 5000 yd. of soil around the broken conduit and was said to have accomplished in two days what would have occupied a force of a hundred men for several weeks.

About 60 ft. of the conduit were torn out and the broken concrete was used for filling the eroded hole and was well rammed down by the loaded excavator bucket. The surface was leveled with broken stone and on it was laid a timber grillage with wooden cradles 4 ft. apart, fitted to the bottom and sides of the steel pipe. The pipe was assembled in these cradles with its ends projecting 30 and 35 ft. into the uninjured portions of the conduit and the vertical sides of the cradles were connected over the top of the pipe by horizontal caps bolted to them.

The steel pipe, in 10-ft. lengths, was made of ¼-in. plate with riveted lap shop joints and inside flange angles for the bolted field joints. Holes were cut in the top of the conduit and through them concrete was placed from the upstream to the downstream end, filling the space between the pipe and the conduit. An effort was made to hasten the setting of the concrete by heating it with coke fires in the pipe and by the use of live steam in the conduit. As it did not harden rapidly enough, the concrete was removed for 2 ft. at each end and there were substituted for it bulkheads made of bricks laid in bitumen and anchored with No. 8 wire dogs from 4 to 6 in. apart.

Injury to Repairs

After the concrete had set twenty-four hours water was admitted to the conduit with the intention of allowing it to run only half full. Unfortunately the pump depended upon to regulate its level could not be operated until there had developed a head at the outlet, thus causing the water to back up the full depth of the conduit at the broken point. This produced pressure on the fresh concrete and washed out several cubic yards at the downstream end, where it became apparent that the brick bulkhead had been improperly built and had a thickness of only 8 in.

Leaks also developed through the flange joints in the steel pipe, and the water was again cut off. A manhole was cut through the top of the steel pipe near the end, giving access to the space between it and the conduit, which was entered by J. A. Jamieson, consulting engineer, retained by the city to report on the break and its repairs. With the assistance of three or four men he built in eight hours a wooden bulkhead to replace the brick bulkhead. Meantime the rubber gasketed flange joints were tightened, and as soon as the work was completed the pump was started and filled the conduit, which has since been in constant operation. A pressure gage has been set in the steel pipe and the exterior of the pipe has been maintained accessible for constant inspection until spring, when permanent repairs will be made.

A very thorough inspection of the whole accessible part of the conduit was made and in a length of 4 miles leaks were discovered in six places, where the color of the escaping water indicated that some erosion might be taking place. Wherever this occurred excavations were made to permit an examination of the conduit and concrete catchbasins were constructed to collect the leakage and deliver it through drain pipes to the canal.

The repair work was executed by the Cook Construction Company, the contractor for the aqueduct canal excavation alongside the conduit.

Distribution of Sewage on Filters

Tests of Several Types of Sprinkling Nozzle to Determine Uniformity of Distribution by Means of Sectional Pans and Other Characteristics

By CHARLES HOOPES
Buffalo, New York

PROPER distribution of sewage on filters is by no means the simplest of the problems connected with sewage-disposal design. The work of Gage, Taylor and Gregory has done much toward a solution of the problem, but the problem is manysided. While some of the devices meet a portion of the requirements, most of the experiments and designs seem to have been made with only a portion of the requirements in mind.

For some time the writer has been carefully studying the practical operation of devices for this purpose. Whenever possible, plants in operation have been visited and their practical operation and results studied. Among others the plants at Columbus, Ohio, and Reading, Pa., were studied and much valuable information gained. Inasmuch as there is a great difference of opinion among the men in charge of these plants regarding the efficiency of the different devices, the writer has been much dissatisfied with the practical information to be obtained, and while employed on some special sewage-disposal studies for the City of Rochester he called the attention of E. A. Fisher, city engineer, and John Skinner, first assistant city engineer, to this problem, with the result that careful studies and necessary tests of the different devices were made.

PRIMARY REQUIREMENTS

The unit of distribution used throughout is gallons per square foot per minute. The following requirements were taken as those necessary for a practical device:

Complete Aëration.—The liquid must be so thrown or tossed into the atmosphere that it is separated into fine particles, so that each particle can come in contact with its share of oxygen. An imitation of a gentle rainfall is the ideal. This breaking up of the masses of liquid also prevents, in a measure, the so-called "streaming" in the filter.

Uniformity of Distribution.—The design and installation must be such that each square foot of the filter receives its proper share of liquid at an equal rate with every other square foot. Irregular distribution overworks portions of the filter and frequently lowers the standard of the effluent below that to be expected from the filter area.

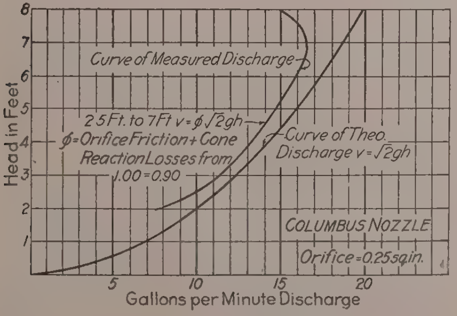


Fig. 1—Measured and Computed Discharge

Freedom of Discharge.—The device should not be easily clogged, and if clogged, the design should be such that the stoppage can be easily and promptly removed. There must also be freedom from troubles incident to frost action, especially in plants constructed in the northern part of this country.

Minimum Loss of Head.—In the majority of designs for sewage-disposal plants any unnecessary loss of head is a serious matter. The expense of construction is often increased, long and expensive outfalls are found necessary and often there must be a final resort to pumps or lifts.

Intermittent Distribution.—The design must be such that it readily lends itself to an installation whereby a uniform film of liquid may be distributed over the filter surface during a predetermined period. This period should be followed by one of rest.

Freedom from Mechanism.—The device should be free from loose or working parts, control valves or the like. Mechanism always means uncertainty of action, besides additional expense in construction and operation.

The requirements promptly eliminated all trickling pipes, overflow troughs and swinging and rotating arms. The solution of the problem is confined at present to some one of the vertical jet devices or sprinkling nozzles. Two general types of these seemed more nearly to meet the requirements than any others, and tests were confined to them.

TESTS

It was the endeavor in the tests to reproduce working conditions as nearly as possible. A large barrel was procured and a 4-in. suction hose connected into its bottom. This barrel was suspended in one of the city's public-bath houses by a chain hoist to one of the roof trusses over the swimming pool in such a manner that its water surface could be moved through a vertical range of 10 feet. A heavy cross of 3-in. pipe was connected to the suction hose, with a quick-opening valve between; there were proper fittings at its extremity to receive the different nozzles. This cross was carefully leveled with wedges so that the axis of the nozzle should be truly vertical. The cross was then heavily weighed with pig lead.

Ten pans were constructed of heavy galvanized iron. These pans were so made that when fitted together they formed a 30-deg. sector of a circle with a radius of 10 ft. Each pan was independent of the others, was 6 in. deep, and had a splash apron at a depth of 1 in. inside. The area of each pan was carefully calculated and its weight ascertained. Scales, weighing to grams, were used throughout. When the pans were in place the outside edge of each lay in the circumference of a circle the radius of which was an even foot, with the axis of the nozzle as a center. The pan bottoms were leveled and were 0.75 ft. below the nozzle orifice.

The air of the building was still, and as nearly one-half of each spray cut the surface of the swimming pool it was possible to study each spray as outlined upon the water surface. Hose connection was made between the city water supply and the suspended barrel. The feed was throttled until it was found, by trial, that the supply slightly exceeded the discharge of the nozzle at the head observed. Great care was taken in observing the exact period of time between throwing the lever of the quick-opening valve on and off.

The periods of discharge observed ranged from one to four minutes, and, after carefully weighing and emptying each pan, the observation was repeated to eliminate error. The nozzle was then allowed to discharge for about five minutes, so that its action and the shape of its spray could be studied. Tests were made at each foot of head from 2 to 9 ft. No allowance was made for loss of head in the piping. The area of the smallest fitting to the area of the largest orifice tested was as 20 is to 1.

The first type of nozzle studied may be described as the inverted cone carried on a central spindle, with a cross-bar within the orifice. This nozzle was of two styles—one to throw a square spray, the other a hexagonal spray.

SQUARE SPRAY NOZZLES

The square spray was tested first, with the following results: Aëration was incomplete, especially along the lines of the diagonals. The liquid along those lines was not only finely broken up but streamed like the discharge from a hose. This stream effect was plainly noticeable and the solid masses of water had sufficient striking force to drive a portion of the liquid from the pans, in spite of the splash apron. Along the sides the results were better, but owing to the flat trajectory and the attempt to concentrate the spray upon a narrow periphery, the particles traveled so closely together that they joined before reaching the pan, forming large drops. Besides its effect on aëration, this feature must also

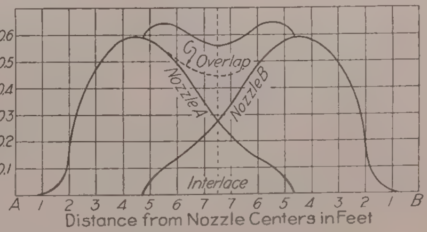


Fig. 2—Mass Curve Diagram

Columbus nozzle. Area of orifice = 0.25 sq. in. Mass curves show distribution in still air, head decreasing uniformly from 8 to 2 ft., sprays of two nozzles interlaced. Period = 7 min. Other periods of discharge with uniform change of head may be studied if proper values be substituted in column of gallons per square foot. Nozzles 15 ft. centers on equilateral triangle. Mass curve C on line from nozzle to center of triangle.

cause "streaming" in the filter to the detriment of bacterial action.

The distribution was irregular. The spray was not square but had rounded corners. If the nozzles be so spaced that the sides of the so-called squares be in contact, there will be a well-defined dead area at the intersection or point of junction of any four. This area will be wet, but it must be borne in mind that there is always a fine mist or halation, if the word may be so used, immediately outside of the main spray body. This, in connection with some spattering, will keep the area wet, but no great amount of liquid will be deposited. The rate along the diagonals maintains its ratio as the head decreases, and is much greater per square foot along a narrow path than on each side.

DISCHARGE

The discharge was affected by the crossbar and spindle inside of the orifice. If clogged, the nozzle must be removed before it is possible to remove stoppage. This nozzle would give better results if somewhat elevated above the filter surface; but in the majority of economic designs the difference in elevation between the flow line of the tanks and the filter surface represents approximately the available head. Any raising of the nozzle means a consequent depression of the filter or a serious loss of head.

The square nozzle may be so installed as to distribute intermittently, but there are two different mass curves that are possible —one along the diagonal and the other along the short diameter. These curves vary materially. Both the rate per square foot and total discharge per minute are different along these two lines. This could be partly overcome by the use of mechanism or a complicated system of central valves. If the nozzle and spray could be made to revolve on its axis during the period of discharge, as well as recede from the periphery toward the center, the distribution would be better.

Anything that has been said of the square spray can be said of the hexagonal, but in a lesser degree. In shape it closely approaches a circle. The corners are rounded and occasionally, perhaps because of the faulty casting, the stream along the diagonal shoots far beyond the corner of the hexagon. There is the same streaming, irregular distribution and joining of the particles before reaching the filter. The general results are much better, however, and if this nozzle were a plain cone it would be a very efficient distributing device.

COLUMBUS NOZZLE

There is little real difference between the preceding types of nozzles and the so-called Columbus nozzle. Both depend upon an inverted cone for diffusion, but in the Columbus nozzle the cone is much shorter, has a different angle, and is carried on outside arms instead of a central spindle. These arms are ground to a thin, knife-like edge, which, as will be seen later, do not materially affect the spray. The nozzle was designed under the direction of John H. Gregory, and is in use in Columbus. While the nozzle was intended to be used with a fixed head, it more nearly meets the requirements than any other device.

The aëration with the Columbus nozzle is nearly perfect. The liquid is so tossed into the air that it is broken up into minute particles and, as these particles are diffused rather than concentrated, they reach the filter in a good imitation of a gentle shower. The distribution is very uniform on concentric areas at any head. It has always been supposed that the splitting of the spray by the knife-like arm would heal, at least under certain heads. Curiously enough, it was noticed that the split did not heal under any conditions, but appeared clearly defined on the water surface as a small notch cut from the periphery of the circle. This notch was never more than 10 in. deep, with curved sides, rounding more sharply into the periphery of the circle and about 3 in. across in the widest part. A slight air current caused by waving a hat some distance away caused it to disappear temporarily. No difference could be detected in the amount delivered per pan with the arm turned toward the sector or at right angles.

The orifice is free from inside obstruction. Anything caught on the arms is easily removed. The writer is informed that at Columbus the number of nozzles in trouble ranges from 1 to 3 per cent, and most of these stoppages are partial. At Summerville, N. Y., there is a small filter, designed by Mr. Skinner, of Rochester, N. Y. The writer has carefully watched this filter and the nozzles have operated continuously for weeks at a time without stoppage.

The nozzle tosses its spray upward rather than outward. For this reason it works well at low heads and, even at low heads, its diffusing qualities are excellent. The uniformity of its peripheral distribution and its diffusion render the problem of intermittent distribution a simple one.

The simplicity of its discharge curve—following, as it does, the theoretic curve very closely—and the fineness of its spray obviate the use of mechanism. The change of head should be at a uniform rate, which means practically a straight-sided tank. The tank can be modified in shape, however, or the sprays can be interlaced, or both.

DIAGRAMS

The accompanying diagrams were originally constructed as aids in the design of sprinkling filters. They are reproduced to illustrate more clearly than words can some features of the Columbus nozzle. The discharge curve diagram, Fig. 1, is interesting. It will be noted that the curve of measured discharge turns back upon itself at the 7-ft. mark. This agrees with the law of hydromechanics governing a vertical jet in air. It is readily seen from the curve that the greatest efficiency, without waste of head, is attained when the device is operated at heads between 2 and 8 ft. This will be true of any jet device.

Cone reaction is also a factor, and the writer gives the following simple formula for the calculation of nozzle discharge from Columbus nozzles, for heads of from 2½ to 7 ft.:

Orifice friction = 0.03; air resistance and cone reaction = 0.07; $V_m = \phi V \sqrt{2gh}$; $\phi = 1.00 - (0.03 + 0.07) = 0.90$; $V_m = 0.90\, V \sqrt{2gh}$.

The curve of measured discharge should be very close to the correct result. It is based on twelve times the total amount received in pans per minute, or twelve times the content of the 30 deg. sector, and checked by the mean rate times total area served.

The mass-curve diagram shows distribution. The two curves marked respectively "Nozzle A" and "Nozzle B" are the curves of two independent nozzles, without interlacing, and, as drawn, show amounts in square feet for a period of seven minutes, assuming that the head decreases uniformly from 8 to 2 ft. These curves are constructed by summing the ordinates of the overlaps and discharges at any given distance from the nozzle. Any required period may be studied by substituting the proper values for gallons per square foot for the period required. As drawn, the two sprays are interlaced and the portion marked "overlap" is found by summing the ordinates of "interlace" and the original curve. Ordinates of the outside irregular curve represent the distribution in gallons per square foot along the line connecting two nozzles for a period of seven minutes.

The dash curve, C, taken in connection with the first portion of the curve for nozzle A, represents distribution along a line drawn from any nozzle to the center of the equilateral triangle, the sides of which connect three contiguous nozzles. Not counting the small dead circle surrounding each nozzle, these curves represent maximum and minimum distribution over the filter surface when sprays are set 15 ft. center to center at the extremities of equilateral triangles.

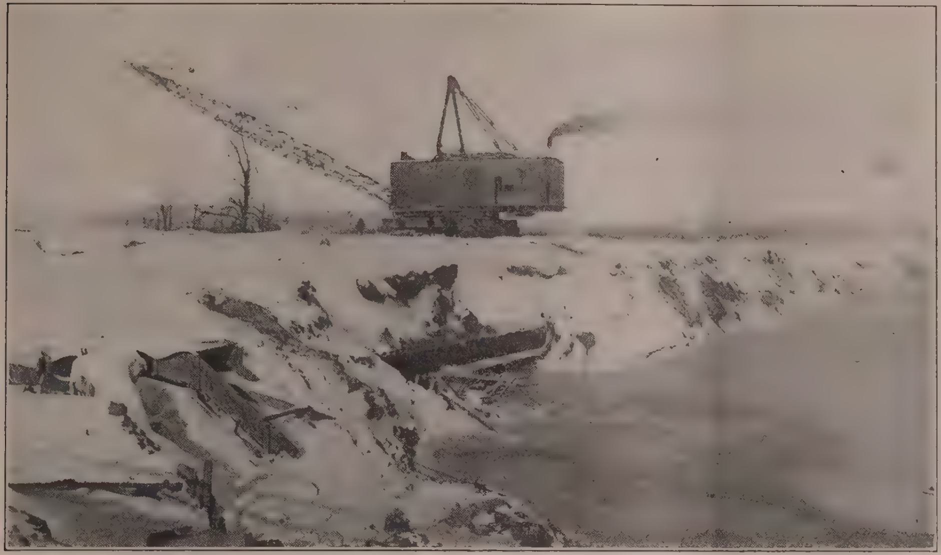
It is readily seen that the distribution is remarkably uniform. In practice, light air currents cause a plume-like waving to the spray, which still further equalizes the distribution.

SPACING OF NOZZLES

The mass diagram is intended to show the maximum allowable interlace. In designing, the writer calculates on a maximum head of 7 ft., which somewhat modifies the curve. Any spacing of nozzles, with the same head of 8 ft. maximum, can be studied from the diagram by tracing the curves for nozzles A and B and moving them apart along the line *AB*. Of course, the areas of interlace and overlap must be changed to correspond.

Diffusion and complete aëration at low heads are two of the most valuable features of this nozzle, and these features are of primary importance. On account of its fine spray and its trajectory it is not seriously affected by interlacing. The distribution can be made still more perfect by shaping the dosing tank. This, in combination with interlacing, gives the best results in practice.

TECHNICAL education for the Chinese is provided by the German Government, which has established in Shanghai the first of a number of engineering institutions. The purpose of these schools is to educate Chinese engineers and officials and thereby strengthen the German influence in China and increase German exports. The Chinese receive their primary education in a so-called "school of the German language." The course in this school extends over three years, and a class of eleven was graduated last year and sent to the "school of engineering." Of these eleven students five were sent back to the primary school owing to insufficient knowledge of German and mathematics, but the others are said to be progressing rapidly. In the near future it is hoped that sixty pupils will graduate every year. The school has been favored with gifts from German manufacturers.



Excavator on Bank over Broken Conduit

Break and Repair of Montreal Conduit

Abstract of Report to the Board of Commissioners of the City of Montreal by the Board of Consulting Engineers, Consisting of J. A. Jamieson, R. S. Lea and G. R. Heckle

On the afternoon of Dec. 25, 1913, a break in the water-supply conduit of the City of Montreal entirely cut off the city's water supply until Jan. 2, when temporary repairs had been executed. A board of consulting engineers was retained by the city commissioners and under date of Feb. 21 submitted to them a report on the history and condition of the conduit, the cause of its failure, and the action which should be taken in the interests of future welfare and safety. This report shows that the conduit, although well built, was not designed with sufficient strength, and that its weakness, together with adverse conditions due to excavation alongside, caused the accident. They recommend the immediate construction of a new supply conduit, changes and careful supervision of the present structure, and material modification of the adjacent work in progress.

HISTORY AND CONDITIONS

The conduit was built in 1907 to protect the city's water supply from surface pollution between the St. Lawrence River and the pumping station and to provide for continuous service during the enlargement, for hydraulic-power purposes, of the open canal parallel to it which had previously delivered the supply. The conduit was completed in the latter part of 1909, and about the same time a contract was awarded to Quinlan & Robertson for enlargement No. 1, which increased the cross-section of the open channel sufficiently to deliver water for the development of 2500 hp in winter and 5000 hp in summer, to be utilized for pumping the city's water supply.

Before the entire completion of the enlargement contract it was decided to increase the water power sufficiently to provide for the generation of electric-lighting current, and the contract for aqueduct enlargement No. 2 was awarded to the Cook Construction Company July 17, 1913. In order to secure the necessary cross-sectional aqueduct area and keep as near as possible within the limits of the city's property, enlargement No. 2 required the excavation to be carried much closer to the conduit than did enlargement No. 1.

About 2200 ft. from its upstream end the aqueduct is now closed by a transverse cofferdam. Above this cofferdam the aqueduct is filled with water up to river level and below it enlargement No. 2 was executed by 3-yd. buckets, which dug into the earth slope while they were being hauled up by heavy machines to the top of the bank where the soil was dumped, some of it over the conduit.

The soil through which the aqueduct is being excavated and in which the conduit is embedded for the greater part of its length is largely composed of boulder clay or rock powder. When comparatively dry, or well drained, it will stand in a bank with practically vertical face, but when fully saturated with water it tends to flow to a horizontal surface and is easily eroded and transported by running water. This latter property has a direct bearing on the safety of the conduit, in view of the proximity of the aqueduct excavation.

DESIGN OF CONDUIT

The conduit, about 2750 ft. long, was designed and constructed under the direction of George Janin, chief engineer of public works for the City of Montreal. In soft ground it has a horseshoe cross-section, with outside height and width of about 9 and 11 ft. respectively. It is constructed of concrete lightly reinforced with Clinton wire cloth and carries water at a gravity head varying from 6 to 12 ft. The dotted line below the springing line of the arch shows the form used in firm soil or rock, in both of which cases the reinforcement was to be omitted below a point 12 in. below the springing line. In firm soil the earth was to be excavated to the neat line at the bottom of the side walls. In rock any excess excavation was to be filled with lean concrete made up of 1 part cement, 3 parts sand and 8 parts of 3-in. broken stone.

The wire reinforcement was accepted as a substitute for the No. 6 expanded steel 6-in. mesh, required in the specifications. As the maximum fill over the conduit is about 25 ft. the concrete sections are lighter than are warranted by safe engineering practice, and the percentage of steel reinforcement is not adequate for the stresses to which the structure is subjected, especially in consideration of the fact that the conduit is the only source of water supply for the city. So far as information is available it does not appear that the reinforcement used is an adequate equivalent for the standard metal specified.

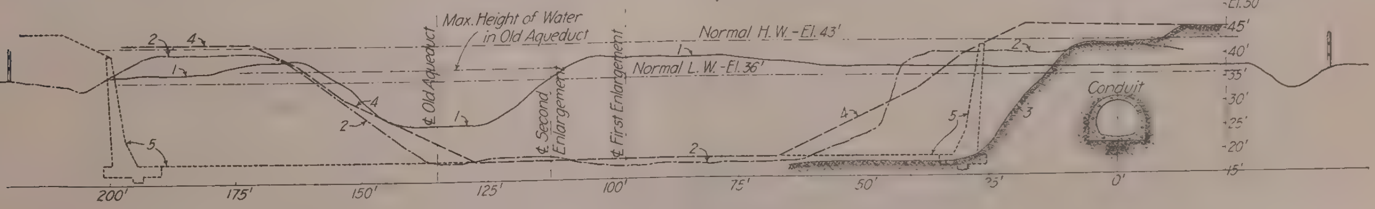
ACCIDENT TO CONDUIT

The location and operation on top of the bank, and sometimes over the aqueduct, of the 120-ton excavating machines used in the execution of aqueduct enlargement contract No. 2 imposed a heavy live load on the conduit concurrently with the removal of its lateral support on the aqueduct side, the effect being to cause a readjustment and sliding of the bank, which tended to produce excessive stresses in the conduit.

During December one of these machines was working over the conduit between stations 119 and 129, where the excavation was carried so close to the conduit that an earth slide partly exposed its side between stations 123 and 124. Considerable water was observed leaking through cracks in the side of the conduit here and attempts were made to stop the leaks and support the conduit, but without success. At about 4:30 p. m. Dec. 25 the side of the conduit burst for a length of about 50 ft., as shown in the photograph.

As this break entirely cut off the city's water supply, emergency repairs planned by Messrs. Janin and Lesage were executed by the Cook Construction Company, whose plant and organization were immediately available at the place and enabled the conduit to be put in service again on Jan. 2, since which time the supply has not been interrupted.

On Dec. 28 J. A. Jamieson was retained as consulting engineer and on Dec. 30 R. S. Lea and G. R. Heckle were also retained and two separate inspections of the interior of the conduit were immediately made. The



Cross-Sectional Diagram of Conduit and Aqueduct

Original channel shown by line 1; successive enlargements, by lines 2, 3 and 4; proposed retaining walls, by 5.

concrete was found to be everywhere of good quality and workmanship. Beginning at the river end the conduit for a distance of about 5050 ft., to station 220, where it is buried under earth from 6 to 8 ft. deep, was found to be practically free from cracks or other defects.

Between stations 220 and 214 a crack about 3/8 in. in width was found in the crown of the arch, and in places the roof on one side has sunk down about 3/8 in. farther than the other. There are also corresponding cracks in the invert and signs of strain along the springing line on both sides. These cracks clearly indicate a distortion of the conduit from the overlying load.

Along the cracked section excavated material had been dumped directly over the conduit up to about El. 58, making the overload about 25 ft. above the crown and plainly accounting for the cracked and distorted conditions found. The east end of the cracked section corresponds with the point where the conduit passes from earth into rock.

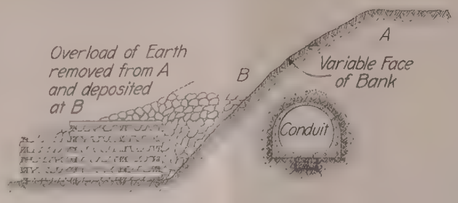
LEAKAGE

A subsequent inspection along the aqueduct bank showed a very considerable leakage of water from the conduit along the cracked section between stations 220 and 214. For the most part this water finds its way into the aqueduct through gravel strata and shows no signs of transporting any of the clay material. The conduit is located at this point approximately 40 ft. back from the aqueduct bank. Between stations 214 and 133 the conduit is located partly or wholly in rock, and was found to be generally in good condition.

Between stations 133 and 120 there are cracks along the crown, on both sides, at about the springing line of the arch, and in the bottom, but these, as a rule, are not open to any extent. They indicate, however, considerable stress and some distortion in the conduit. It was in this section, between stations 123 and 124, that the break occurred, and an inspection made after the conduit was filled with water disclosed the fact that at several points along the bank water was leaking from the conduit and finding its way into the aqueduct.

Between stations 69 and 120 there is a light crack along the crown for a considerable part of the distance, but for the most part this crack is comparatively small. An apparent leak has been found in this section near station 94, but the water was running out through gravel strata and was quite clear, indicating that the leakage is probably not endangering the conduit at this point.

Between stations 69 and 50 the conduit is cracked along the crown and in the invert, these cracks being open for the most part about 1/8 in., and by cutting into the concrete at certain points it was found that the reinforcing wires were broken in the crown. There are also some cracks at about the springing line of the arch. Along this section it was found that the original fill over the conduit was only about 5 ft., but that during the operations for enlargement excavated material from the aqueduct had been deposited along the bank over the conduit approximately up to El. 45, making the fill about 15 ft. higher than the top of the conduit. This fill is, however, not generally over the center of the conduit, but south of it, thus producing an unbalanced loading. A close examination would indicate that these cracks were not of recent date.



Temporary Crib and Riprap Protection

Between stations 50 and about 30 the conduit was in good condition, showing no evidence of anything beyond occasional fine cracks. It was impossible to proceed further east with the inspection on account of the depth of water.

It was found that the aqueduct had been provided with both head gates at the entrance from the river and regulating gates further down, but that in both cases the gates were in very bad repair, and entirely useless at the present time.

PRELIMINARY RECOMMENDATIONS

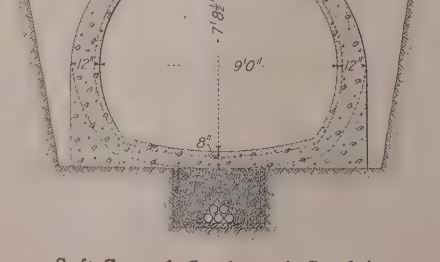
On the night of Dec. 30, after completing the inspection of the interior of the conduit, the following verbal recommendations were made:

1. That riprap be placed against the toe of the slope along the weakened sections in the vicinity of the break as rapidly as possible.
2. That, when the water was turned into the conduit, it should not be allowed to run more than three-quarters full and kept below that depth if possible.
3. That the overload of earth be removed from the top of the conduit for a considerable distance east and west of the break.
4. That the overload on the section lying approximately between stations 214 and 220 be also removed as soon as possible.
5. That the excavation work on the north side of the aqueduct be suspended, and that for the present no blasting be allowed in the rock section on the north side.

INTERIM REPORT

These verbal recommendations were confirmed and further emphasized in a written interim report under date of Jan. 7, in which certain other additional recommendations were made.

This report stated that for a distance of approximately 500 ft. on both sides of the recent break in the conduit the excavation for the enlargement of the aqueduct has been carried too close to the conduit for its safety. The effect of this is that the lateral support on the south side of the conduit has been largely removed, leaving an unbalanced load on the north side. This, combined with the fact that the excavation work was carried down to about 5 ft. below the bottom of the conduit, makes an existing condition not provided for in designing the conduit.



Soft-Ground Section of Conduit

It is recommended that a rock-filled timber crib be built at the present foot of the bank adjacent to the conduit along the weakened section, rock and earth to be filled and tamped between the crib and slope, and the fill to be carried up to the top of the bank over the conduit, the object being to replace the excavated material with new fill and to support this fill with the crib.

In addition, by-passing the weakened section of the conduit with pipes laid along the bottom of the aqueduct and connected to the conduit through concrete head blocks carried down to rock was considered, but the construction of the crib and fill is the first requirement.

Another matter requiring prompt attention is the removal of the excess load from about 600 ft. of the conduit just east of the present cofferdam, and the bank of the aqueduct at that point should be carefully watched so that further precautions can be taken if necessary.

REPAIRS AND PRECAUTIONS

An arrangement was made with the Cook Construction Company to proceed immediately with the carrying out of the work involved. The most important measure—placing riprap along the toe of the slope at the weakened section on both sides of the break, between stations 119 and 129, to be followed at once with the construction of a rock-filled crib—was proceeded with first, night and day shifts being employed.

Simultaneously the very difficult work of securing the conduit at both ends of the steel pipe at the break was being done. This required the utmost care, as it was found that cavities had been eroded by leakage on both sides of the conduit and directly underneath, which, of course, made the situation a very serious one. Blocks of concrete were placed in sections underneath the conduit where the foundation was scoured out, and the leaks in the side were calked and afterward incased in concrete. The water draining through the conduit in both directions toward the break and at other points on both sides was carried in troughs to the aqueduct, so that no further scouring would occur.

When the protection work adjacent to the break was well under way a force was started removing the excessive load from the top of the conduit between stations 214 and 220, a wedge-shaped section being taken off to El. 47, thus removing about half the load over the crown. It was considered advisable to do this work entirely by hand labor, on account of the danger of using machinery adjacent to this cracked section.

The laying of a pipe connecting the Lachine canal with the present pump well was also commenced at once. This precaution is justified by the possibility of another break in the conduit which might expose the city to the danger of a conflagration. This should not interfere in any way with measures being taken as soon as possible for furnishing the city with an alternative supply of pure water, and water from the Lachine canal should not be turned into the city mains except as a last resort.

Water leaking from the conduit under pressure tends to find an outlet through the intervening bank into the adjacent aqueduct, the bottom of which is about 5 ft. lower than the invert. This water erodes and transports the soil surrounding the conduit, removing its lateral support, and the leaks are a serious source of danger so long as the aqueduct remains unwatered.

The only practical way to stop these leaks is by filling the cracks from the interior. This can only be done by unwatering the conduit. Under existing conditions, however, this latter cannot be done within a reasonable time owing to the fact that there is only one 12-in. pipe through which the conduit can be drained. The suction pipes of the pumps at the pumping station do not extend sufficiently low by several feet to permit the conduit being unwatered by pumping.

DESIGN OF RETAINING WALLS

The contractor for enlargement 2 is required to construct reinforced-concrete retaining walls along both sides of the aqueduct in the earth section and plain concrete retaining walls in the rock section. No particular provision has been made by which the contractor is obliged immediately to follow up earth excavation with the construction of the retaining walls. Moreover, the contract provides that the contractor construct test sections of the wall when ordered by the engineer and before proceeding with the general construction. This would seem to indicate that the city engineers did not expect the contractor to follow up his earth excavation very closely with the retaining walls, and they themselves were not quite satisfied that the wall as designed was sufficiently strong for the purpose intended.

It is obvious from what has already occurred and from the present condition of the north bank in the earth section that unless the wall construction follows the excavation very closely the conduit will be greatly endangered, as there are points east of where the break occurred where the plans show that the excavation was to be carried much closer to the conduit than at points already excavated.

Analysis shows that the reinforced-concrete wall specified would not be stable for the loads which it is prudent to assume it would have to sustain.

Another apparent weakness in this design is that the bottom of the concrete base is only 21 in. below the bottom of the canal. If the structures were left exposed during construction in the winter time, or if, at a later period, the canal should be emptied of water in the winter time, there would be great danger of the frost penetrating under the base causing serious damage to the wall.

CONCLUSIONS

The board of consulting engineers submits the following conclusions:

1. That the plans and specifications of the conduit did not call for sufficient reinforcement, nor is the steel properly placed in the concrete section to provide a sufficient factor of safety, especially in view of the fact that the conduit would be the only means of supplying the city with water during the enlargement of the aqueduct.

2. That in the construction of the conduit the quality of the concrete and the workmanship generally were good, but that the weight and strength of the steel reinforcement were much less than called for by the specifications submitted.

3. That the insecurity of the conduit was greatly increased by the proximity of the excavation involved in carrying out enlargement 2.

4. That the method of performing the work by means of a heavy dragline excavator traveling on top of the bank above the conduit, imposing a heavy vibrating load concurrently with the removal of the earth which provided lateral support to the conduit, further endangered the structure.

5. That the leakage of water from the conduit is an additional source of danger at points where the conduit is located in easily eroded soil and the excavation carried sufficiently close to permit the water finding an outlet into the aqueduct.

6. That the failure of the conduit was due to the proximity of the excavation, to the methods employed in the execution of the work, and to the inherent weakness of the conduit itself.

7. That the conduit, as a permanent means of supplying water to the city, is not now to be depended upon.

8. That it would be unsafe to proceed with any further excavation in the earth section on the north side of the aqueduct with the conduit in its present condition and while there is no other water supply available.

9. That it is unsafe to do any blasting in the rock section on the north side of the aqueduct.

10. That it is unsafe to allow the traveling excavators or locomotives or any other similar heavy machinery to be operated on or moved at any point over the top of the conduit.

11. That the reinforced-concrete retaining wall, as designed by the city to be built for enlargement 2 along the banks of the aqueduct in the earth sections, is not a safe structure to build for the purposes intended.

12. That a revision of the design of this wall, in order to make it safe, will greatly increase the cost of the project.

RECOMMENDATIONS

Besides the recommendations already noted it was further recommended:

1. That before any other work is proceeded with, at least on the north side of the aqueduct, an investigataion be made by a commission of engineers into the entire aqueduct scheme, which will include revised estimates of the cost of construction and the quantity and cost of the power developed.

2. That the city at the earliest date possible make arrangements for providing a new and independent water supply of a suitable character, so located that it cannot be affected by any further accident which might happen to the present conduit.

3. That a permanent cofferdam or intake be at once constructed at the entrance to the aqueduct, including proper gates or sluices that may be required, so that the flow of water into the aqueduct may be at all times under control.

4. That until another suitable water supply has been provided the present one should be kept continuously under observation, so that in case the present leaks become serious prompt remedial measures may be taken.

5. That the suction pipes of the pumps at the pumping station be lowered by at least 6 ft. as soon as possible, so that the conduit may be run partly full or may be quickly emptied.

TWO irrigation dams will be built by the Egyptian Government, one on the Blue Nile and the other on the White Nile. The structures, it is reported, will be larger than the Assuan dam, and the estimated cost ranges from $15,000,000 to $17,500,000. Thousands of square miles of desert south of Khartoum will be converted into farms.

Business Management for Cities

Abstract of Address by Henry M. Waite, City Manager of Dayton, Ohio, before the Indiana State Sanitary and Water Supply Association at Indianapolis, February 26

LET us consider our past experience with the various systems of municipal government. Under the prevailing forms there have been at least two parties always enrolled for action, one in power and entrenched, the other waiting to be entrenched and not above intrigue and distortion of facts to gain the ascendency. Apparently our idea of improving municipal conditions has been to put the attacking party in power, which merely reversed the situation. This operation continued indefinitely and the improvement likewise was indefinite.

This procedure on our part built up strong parties or local organizations, controlled and guided by a wonderful unofficial spirit, inspired by love of gain or power, remaining always in the background and unassailable because he was unofficial. He gathered about himself an organization made up of men that would make good workers at the polls and who were good "mixers" with the people. This organization was held together by the promise and expectation of occupying city positions. The greater the political efficiency of a member, the more remunerative was the job. The result was that our cities were being run and operated by men who were not particularly trained for the positions which they were called upon to fill in the city government.

The first permanent step away from the old form of municipal government was the commission form. Here we selected our commissioners and assigned to them certain governmental functions, either by vote or by selection after they were elected. Again we were confronted by failure of the ballot to select the right men to take charge of particular functions of government that required training and experience for efficiency.

COMMISSION-MANAGER FORM IN DAYTON

The most recent step has been to the commission-manager form—the application of the business organization of successful corporations to municipal government. In this form we elect our commission, which in turn selects a business manager for the city; he chooses the heads of the various departments. The commission in a corporate organization would represent the directorate; the manager would represent the executive head or the president of the corporation. In Dayton the organization of departments is on the pyramidal form and is based on five as the ideal number. We have five commissioners as the legislative body who employ the city manager, and under the city manager there are five directors at the head of the five principal functions of government—namely, service, safety, welfare, finance and law. These are selected and appointed by the city manager.

Here is the first and principal application of business methods to city government. Under the old form we voted for the heads of the various departments. It would be just as reasonable to expect a corporation desiring to fill a particular vacancy in its organization to go out and ask the neighborhood to vote on some one to fill that particular place. When a private corporation desires to fill a particular vacancy in its organization it selects the man who it believes will perform those particular functions with the greatest economy and efficiency, and the salary paid is in accordance with his worth to the particular business desiring his assistance, no other ties or conditions being considered.

Dayton elected as commissioners five solid, successful, brought-up-from-the-ranks business men, who in turn employed a manager whom they believed, because of his record, could fill the position. The manager after a careful study of the situation has chosen his directors from material available in Dayton, with one exception.

QUALIFICATIONS OF DIRECTORS

The director of welfare has charge of health, parks, playgrounds, charities, corrections and social betterment. The man now in office has made this work a study, having spent several summers abroad observing the social conditions in foreign cities, as well as having conducted similar studies in this country.

The director of finance is at the head of the accounting, financial and purchasing departments. The man selected has spent much of his life as treasurer, auditor and in the purchasing departments of manufactories in Dayton, and the latter years have been spent as a public accountant.

The city attorney's duties are self-evident. He is one of the leading attorneys of Dayton, who was willing to sacrifice his own business interests to accept the position.

The director of service has charge of the waterworks, all engineering, contracts, maintenance of streets and sewers, the handling of garbage and ashes, and supervision of all public utilities. The man holding this position has had experience in large construction work and municipal work and was my principal assistant engineer in Cincinnati.

The director of safety has charge of the police and fire departments. This position has not yet been filled, and the duties are being taken care of by the city manager.

It is impossible for me to tell you today the political faith or inclination of any of the appointees above mentioned, nor is it possible for me to tell you the political faith of any appointees whom I have named since I have been in Dayton. We simply insist on three requisites—efficiency, economy and loyalty.

In all public work we are confronted with the idea that is grounded in the minds of most men that they do not have to do as much work nor do they have to take as much interest as they do in individual or corporate concerns. Civil service likewise does not produce ideal results from an operating standpoint. But we believe that better results can be obtained under the commission-manager form than under the older forms, due to a more efficient method of selection and removal by the application of our successful business methods to our municipal government.

A CULVERT under a 170-ft. fill was recently completed on the Columbia Western Railroad about 30 miles west of Robson, B. C., where a high trestle on the Cascade Tunnel grade has been filled in. The crossing is in a narrow canyon, and it was considered cheapest to sluice the fill material from the adjacent hills by the use of hydraulic giants. The culvert, which is about 500 ft. long, was built up of masonry and has an arched roof with a span of about 12 ft.

Educating the Man in the Shop

An Account of the Work of the University of Wisconsin's Extension Division, which Conducts Correspondence Courses in Engineering Subjects

By EARLE B. NORRIS
Associate Professor of Mechanical Engineering

IN the extension division of their State university the people of Wisconsin possess the largest scheme for the education of the people that any college or university has ever developed. Since its reorganization in 1907 under the leadership of Dr. Louis E. Reber, formerly dean of engineering at the Pennsylvania State College, the university extension division has come to be recognized as one of the leading elements of the State educational system. University extension represents the recognition of an educational responsibility extending beyond the confines of a college campus and offers the service of the university to the people of the State in every line of educational endeavor for which it is the best fitted instrument.

From the inception of this work, engineering extension has played a most prominent part. The work done in engineering can be broadly divided into two phases—instruction to the individual in technical matters and service to the individual or to the community in matters of public welfare demanding expert technical knowledge. In this way every industrial worker can secure instruction regarding the materials and processes with which he is concerned, and every community has at its command the knowledge and experience of others on the technical problems affecting the general welfare of the community.

METHOD OF INSTRUCTION

The method of instruction is the correspondence method, supplemented by personal consultation or class instruction wherever possible. In the last six years more than 6000 men and boys have received technical instruction through this service. The tremendous growth of the commercial correspondence schools is abundant evidence of the demand for this form of instruction. There is every reason why this work should be done by a public agency, doing more effective work at less expense to the student.

The correspondence method is not only an effective one, but, in the majority of cases, is the ideal method for this work. The student is enabled to adapt his educational progress to his own interests and conditions; he is not bound to a class schedule; his progress may be fast or slow, according to his ability and time available. Unlike the student in a technical school, he is not removed from the industrial atmosphere for a long period of instruction. Every day he returns to the shop or office and puts into practice the things learned in his studies of the previous evening. He thus sees the application of every new thing as he learns it. His place of employment becomes his laboratory.

The courses are prepared and the correspondence instruction is carried on by a corps of eleven engineering professors and instructors at the university at Madison. Their work is supplemented by that of seven "field instructors" in engineering—two in Milwaukee and one each in Oshkosh, La Crosse, Superior, Wausau and Eau Claire. These field instructors visit the leading industrial centers in their districts at regular intervals and give personal assistance to the engineering students, or meet them in classes when there are a sufficient number in a community interested in one subject. These classes meet at their places of employment, or at the university extension district offices, or at the public school or library buildings. The classes differ from the usual class organizations in that each student studies by himself and can go as rapidly as he desires, doing his work by correspondence, but receiving help and inspiration at regular intervals from the instructor. The spirit of class rivalry is obtained without sacrificing the flexibility of the correspondence method.

CO-OPERATION OF MANUFACTURERS

A large percentage of the classes have been organized with the co-operation of the manufacturers, who have equipped classrooms, given the men time from their regular work to attend the classes, and in some cases have partly or wholly paid for the courses of instruction. The classes meet once a week or once in two weeks. In some cases, where the classes are made up of apprentices, the men have been given half a day each week for this work. Where there are not a sufficient number in one plant to form a class, they may be grouped with others to form an evening class at some convenient center.

The class organizations are usually in the more elementary vocational subjects. In the more advanced subjects the men usually prefer to carry on their work by themselves, with occasional opportunity for private consultation with an instructor. In some of the more technical subjects the class organization affords opportunity for occasional lectures on the subject by a specialist from the university. This has been successfully applied to classes in heating and ventilation, in gas engines, in factory organization and management, and other subjects.

The separate corps of extension teachers has been found of especial value in the engineering work. The extension work requires a distinct type of teacher—one who has had considerable practical experience and who knows and sympathizes with the practical man's viewpoint and interests. The advice and co-operation of the faculty of the engineering college have been of inestimable value. In its summer session the college of engineering offers a special opportunity for extension students to supplement their correspondence instruction with further laboratory work and lectures where needed. Many extension students have taken advantage of this opportunity. For example, during the last summer a young stationary engineer who had studied power-plant mathematics, heat, steam engines, boilers, gas engines and gas producers took work in the mechanical laboratory to acquire a broader experience in the handling and testing of power machinery. In another case, the meter-repair man of a large central station, after studying a course in electrical meters by correspondence, took a special course in meter testing at the university to acquire a broader experience than he could obtain at home.

The success of the extension work has depended, more than any other one thing, on the nature of the courses offered. In nearly every case it has been necessary to develop special texts for this work. The average text book leaves considerable to the personal contact with the instructor. The extension text must be complete. Furthermore, the instruction must be alive; it must get and hold the student's interest from the start. This by no means indicates that the instruction should be superficial; on the other hand, it must be thorough but practical. Furthermore, the courses must be in short units, each standing for some definite accomplishment.

CHARACTER OF COURSES

The extension student takes up a study with the idea of filling a present need; he has reached a point in his work where his further advancement depends on his having a certain knowledge which he cannot acquire in his everyday work. He sees only the immediate future, and a long course of study extending over several years offers too remote a promise. For those with greater vision, the shorter courses can be grouped into long courses leading to some particular vocation or profession.

The extension division is now offering some seventy courses in technical subjects. In mechanical engineering there are courses in mechanics, strength of materials, mechanism, gas engines, gas producers, steam boilers, heating and ventilation and refrigeration. In civil engineering there are courses in hydraulics, elements of structures, three courses in the different kinds of reinforced-concrete structures and courses in bridges and buildings of different kinds. In electrical engineering there are courses in electricity and magnetism, electric meters, electric wiring, alternating currents and alternating-current machinery. For shop men there are courses in shop mathematics, drawing and cupola management, besides the mechanical engineering courses. For draftsmen there are several courses in drawing and machine design. For those in the business side of industry there are courses in factory organization and management and cost accounting.

ENROLLMENT

Since the inception of this work, about six years ago, the number of students enrolled in the various technical branches up to Nov. 1, 1913, was as follows: Shop mathematics, 1805; drawing, 1210; mechanical engineering, 839; electrical engineering, 521; structural engineering, 571; surveying, 37, and business courses relating to industry, 1197—a total of 6180. In addition there are others taking general courses for credit toward the regular university courses in engineering.

The work is going on throughout the year and students may begin work or complete it at any time. Furthermore, the students will take various lengths of time to complete their work, so that it is difficult to give definite figures of results accomplished. Taking the number, 731, who completed or discontinued work in the past year, 60 per cent of them finished their courses, while 40 per cent discontinued or were dropped for various reasons—some because of a change of occupation, some because of circumstances which made further study impossible, and some for lack of interest or inability to carry on the work. Certainly this is a remarkable showing when we consider the conditions under which many of these men work and study. Many of the students who have been compelled to discontinue have derived much of value from their studies.

RESULTS

The real results are measured, however, in the increased efficiency and economic value of the men, and of these there is abundant evidence. There are numerous cases of men who have advanced to positions of foremen, superintendents, managers or other responsible posts, and the correspondence files at the university are replete with interesting letters from students telling in the most grateful terms of advances in salary and position. It will be seen that this work has filled a real need and found a permanent place in the educational system of the State, for surely no instruction is more worth while or better appreciated than that which proves its value by the figures on the pay check.

In addition to the formal instruction in the correspondence courses much is done by means of lectures to engineers' clubs, civic clubs, business men's associations and labor organizations. Another interesting phase of the work, which has reached thousands of people, is the sending out of "package libraries"—bundles of special articles, bulletins and magazine clippings giving information on subjects of general interest which do not require formal courses of instruction. Popular bulletins on technical subjects of general interest are also issued by the department. For example, a bulletin is now being prepared on the subject of sewage disposal for country homes.

MUNICIPAL REFERENCE BUREAU

Through the municipal reference bureau of the extension division, with the co-operation of the engineering staff, another form of service is being carried on with most valuable results. Many wasteful experiments in public improvements can be prevented if our city officials and the public are properly informed of the experiences of others. In this bureau are collected the results of experiments on such matters as highways and pavements, sewage and garbage disposal, municipal ownership, systems and costs of street lighting, and other questions of municipal government. This information may be given in the form of digests or reports, or as lectures to interested groups of citizens. This service has reached practically every municipality in the State.

The department also offers expert advice to citizens or communities on matters of general welfare. The nature and value of this service are best shown by a recent example. In a small northern town some of the more progressive citizens felt the need of a sewage system. Before public sentiment could be crystallized it was necessary that they should know something of the proper plan to be followed and the probable cost. In this predicament they appealed to the extension division and an engineer from the university was sent to advise them. With a definite proposition outlined for them, public sentiment was easily aroused, a competent engineer was engaged and the system installed. Having secured the sewer, the same people are now, in the same way, planning for a municipal water supply. They have been advised as to the best location of their wells and mains to insure pure water and good service, and have been given information on the probable cost and the value to the community. Great care is taken not to encroach on the field of the consulting engineer and the employment of an expert is advised at the proper point. This service creates business for the professional engineer by educating the people to the need of securing competent engineering talent.

It will be seen that the results in Wisconsin have shown the real need for university extension as a permanent part of the State educational system. The results achieved have brought forth ever-increasing moral and financial support. Starting with an appropriation in 1907 of $20,000 for the whole work of university extension, it now involves an expenditure of more than $200,000 for the current year. In other States the people are beginning to look to their State universities and colleges for similar service. A recent inquiry revealed the fact that, with only one or two exceptions, all of the colleges are planning some kind of extension work, and in a majority of the schools the work is already under way. Engineering extension promises to the people the same service in technical lines which the farmers have for years been receiving through the agricultural extension work of the State colleges.

Rapid Progress on St. Louis Intake Tunnel

By C. H. HOLLINGSWORTH

Superintendent in Charge

ON the St. Louis waterworks intake tunnel, which is now being driven, a progress of about 25 ft. per day of 11-ft. circular tunnel has been maintained for the last thirty-one days, and for the week ended Friday, Feb. 20, at 8 a. m. the progress was 184 lin. ft. of tunnel, or a rate of 26.3 ft. per day. Since Jan. 21 each shift working eight hours has mucked out, set up, drilled and shot twice. The greatest progress made in one shift was 10.9 ft. and the greatest progress on one shot was 6.6 ft.

No attempt at making a record was made, as the tunnel had to be driven to line and grade, and while it only ran 3½ cu. yd. per foot its circular shape made it very difficult to muck and allowed little room in which to work. Considerable water was encountered, which gave trouble, as the tunnel grade is only 1 ft. in 1000.

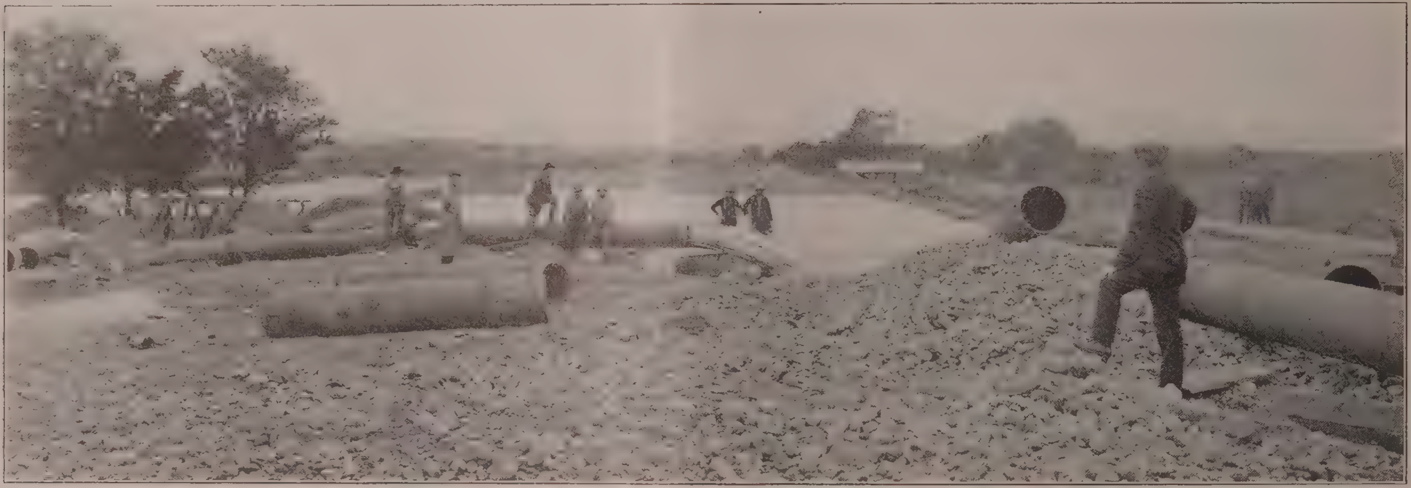
The rock is a hard limestone and four C-110 Ingersoll-Rand drills are mounted on a 10-ft. cross-bar having four arms. The entire face is drilled at one setup. From sixteen to eighteen holes were required to break the ground properly. The muck is handled in 24-cu. ft. wooden cars and is hauled to the shaft by a storage battery electric locomotive. The tunnel runs from the city's present pumping station at Chain of Rocks to a new intake crib in the Mississippi River and is about 2790 ft. long, of which about 2200 ft. are under the river. The latter section is the part on which work is now going forward.

The contractors for the work of building the tunnel and intake tower and screen chamber are the Fruin-Colnon Contracting Company, of St. Louis, and the Missouri Valley Bridge & Iron Company, of Leavenworth, Kan.

Hydraulic Grading for Railroad Embankment

Suction Dredges at Rome, N. Y., Excavate Barge Canal Prism and Pump Spoil into Fill of 1,800,000 Cubic Yards for New York Central Road

IN the extensive work of constructing the New York State Barge Canal and relocating the New York Central & Hudson River Railroad through Rome, N. Y., the general project for which was described in the issue of Feb. 21, page 221, the close relation of the various classes of the work made it desirable to have the entire project covered by one general contract, and the conditions offered ample opportunity for study in the design of plant and the program for the work. It was assumed that the railroad embankment would be made hydraulically from the material dredged from the canal prism alongside, but the problem of obtaining water to float the dredges had to be overcome. Fourteen bridges or arches, besides a number of small culverts, were required, and in constructing them it was necessary to avoid interruption to the operation of the New York, Ontario & Western and the Utica & Mohawk Valley Railways, or of the Erie Canal during the navigation season, not to mention the various streets crossing the improvement. The grading is being done by means of two hydraulic dredges built at Rome, assisted by Lidgerwood dragline scrapers. One central concrete plant, using sand and gravel dredged from the canal prism, supplied the concrete for most of the structures under the New York Central embankment. Special layouts were used to meet the needs of the bridges and arches out of reach of the central plant, efforts being made to utilize the same machinery at as many points as possible without delaying the work as a whole.



Outlet of Pipe Line, Showing Size of Stones Pumped a Horizontal Distance of Several Thousand Feet

GRADING WORK

The grading work is naturally divided into three parts by the old main line of the New York Central. At the east end the only embankment required is for the double-track industrial connection, and this is being made with a Lidgerwood dragline excavator, partly from the ground alongside and partly from a borrow pit. The contract extends several miles to the east, and prism excavation is under way farther east, but that part has no connection with the Rome work proper.

In the large middle section lies the bulk of the grading. Here it was believed that sufficient water would be available from the Mohawk River to float a dredge and that by pumping the spoil into the railroad embankment adjacent it could be built more economically than by any other means. Accordingly, a 20-in. suction dredge, the Stanwix, was built and launched near the intersection of the river with the Barge Canal. The dredge is 120 ft. long and 36 ft. wide, drawing 9 ft. of water. Steam is furnished from two Heine water-tube boilers of a combined capacity of 1000 hp, and the dredge is supplied with a full outfit of auxiliary pumps, electric lights and the like. The machinery for the dredge was furnished and placed by the Morris Machine Company, of Baldwinsville, N. Y.

For several months previous to the commencement of dredging two steam-driven Lidgerwood dragline excavators of 1½-yd. capacity were at work throwing up dikes on either side of the projected embankment, constructing them from the original soil under the center of the embankment, which excavation was subsequently filled by material pumped by the dredge. On account of the general height of the embankment—about 20 ft.—it was impossible, even had it been desirable, to remove sufficient material from this central excavation to make the dikes to the full height of the embankment, so that only about half the total height was placed, new dikes being raised by dragline machines working upon the embankment already pumped in. During the conduct of this work two or three dragline excavators have been kept busy from sixteen to twenty-four hours per day in caring for the material pumped by this dredge by providing impounding areas for this material and in dressing the slopes.

CHARACTER OF MATERIAL

The accompanying photograph shows the nature of the material, some of the stones being as large as a man's head. Gravel of this nature has been successfully pumped 4000 ft. horizontally, in addition to a 40-ft. vertical lift. The material is excellent, both for embankment and concrete, but very hard on the machinery and pipe lines. The ordinary steel castings first used were subsequently replaced with manganese steel, with marked improvement in the life and wear of the casing and piping. The dikes also had to be lined with baffle boards to prevent them from scouring out. Short settling basins sufficed for the deposit of the gravel, and the water was returned to the canal excavation as quickly as possible to keep a sufficient supply to float the dredge.

With the exception of the short portion west of the point where the Ontario division swings off, the railroad embankment has a minimum width of that required for six tracks on 13-ft. centers—that is, 85 ft. As a large part of the fill is from 18 to 20 ft. high, this gives a bottom width of about 140 ft., which is increased at the station and at the yard at the east end.

ONTARIO DIVISION

West of the New York Central a 15-in. suction dredge, the Hanson, was built to supply material for the double-track Ontario division embankment from the New York Central north and for the wyes. Here there is no gravel, the material being a fine sand overlaid with 5 or 6 ft. of decomposed vegetable matter, and requiring different treatment. On account of the instability of this soil as a foundation for a railroad embankment, low dikes were built at the right-of-way lines and the entire intervening space filled with material pumped by the dredge, the total cross-section area being equal to that of the higher but narrower finished embankment. This material is allowed to settle for several months, considerable time being required to get the fine sand dry enough to allow it to be worked. It is then scraped up into the finished embankment by means of a dragline machine, the easily compressed surface soil having by that time become compacted to a state of stability.

Even with the wide settling basins it has been found necessary to make them about 1500 ft. long, to allow all of the light suspended matter to be deposited. This, together with the fact that the embankment leads directly away from the canal instead of paralleling it, and the impossibility of depending on the Erie Canal or the Mohawk River for direct reinforcement, as is possible where the Stanwix is working, make the prompt return of the water to float the dredge a necessity. In order to obtain a sufficient supply of water, use is made of what is known as the "Old Erie Canal," a remnant of the original Erie Canal of 1825. This is a drainage ditch emptying into Wood Creek, west of Rome. It drains the pool of the Barge Canal between the present Erie Canal and the westerly crossing of the New York Central, and is carried under the northerly end of the new Ontario division connection in 48-in. pipes. At the culvert where it crosses the easterly wye a return ditch has been constructed running parallel to the easterly side of the Ontario division fill and emptying into the pool where the Hanson is working. In the culvert a gate is placed by means of which any amount of water desired, in addition to the return water from the discharge pipes, can be deflected into the return ditch, and thus the water level in the Hanson pool can be kept at any desired elevation.

The water level of the present Erie Canal is 9.5 ft. higher than that of the Barge Canal. This difference in elevation in the two canals has seriously complicated the dredging operations. The contractors were not allowed to impede traffic in any way in the Erie Canal during the navigation season—from May 15 to Nov. 15 of each year. Aside from the necessity of locks each side of the Barge Canal to effect the change in water levels—to build which a temporary canal detour was required—the maneuvers of the larger dredge across the Erie Canal had to be made during the season of closed navigation.

QUANTITIES

The Stanwix was built in the winter of 1910-11 and began work July 1, 1911. It was necessary to keep it at work during the following severe winter in order to get it across the Erie Canal before the opening of navigation and permit the work west of the canal to proceed during 1912. In the six and a half months from July to February 574,625 cu. yd. of material were pumped into embankments and spoil areas—an average of 88,500 cu. yd. per month. The maximum monthly pumpage was 174,000 cu. yd.

During the 1912 season the material was generally somewhat finer, but the distance it was pumped averaged greater. The output for the year was 829,300 cu. yd., an average of 97,500 cu. yd. per month for the months in which the pumping was in progress. The greatest daily output was 15,280 cu. yd. Last year the dredge had to pass back and forth under low bridges, necessitating dismantling it, but it was expected that by Jan. 1, 1914, it would have handled 530,000 cu. yd., making a total for the three seasons of nearly 2,000,000 cu. yd. The dredge Hanson began work June 26, 1913, and figures for its performance are not yet available.

The work is being performed by Grant Smith & Company & Locher, of New York, in conjunction with the M. A. Talbott Company, of Baltimore, of which H. M. Knight is engineer. The latter company has the general contract and is building the concrete structures. The engineers in general charge are John A. Bensel, State engineer, and Alexander E. Kastl, deputy State engineer, for the State, and George W. Kittredge, chief engineer, and J. W. Pfau, engineer of construction, for the New York Central & Hudson River Railroad. Daniel B. Donovan and J. D. Black are the respective resident engineers.

Concrete Arch Bridge with Varying Rib Thicknesses

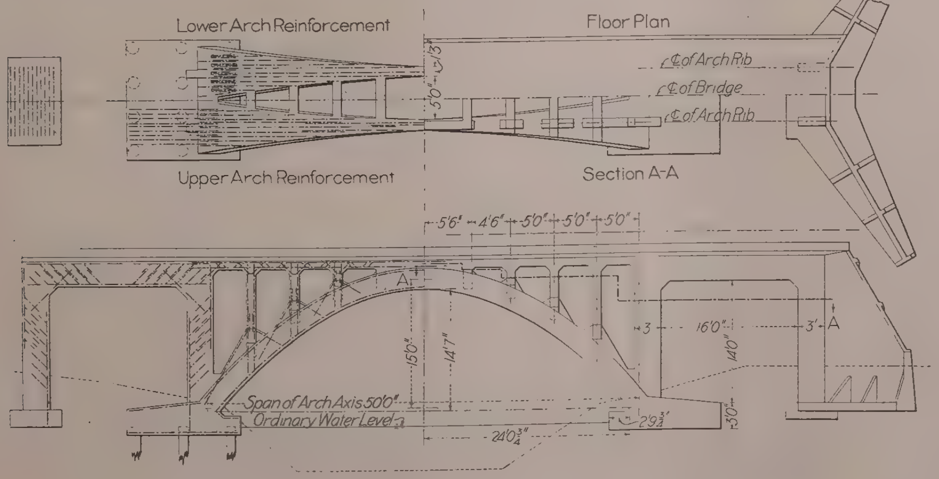
Railroad Structure Adapted to Tropical Flood Conditions of the Hawaiian Islands

In the latter part of 1912 the Oahu Land & Railway Company, of Honolulu, Hawaii, undertook the relocation of about a mile of its line, near Waipahu, Island of Oahu, for the purpose of giving better service in a district of growing importance and eliminating a switchback considered necessary when the road was built in 1905. The old line crossed Waikele creek on a long wooden trestle which had given much trouble on account of the trees and floating débris carried down by the tropical floods. The relocated line crossed this creek at a point where the subgrade was about 21 ft. above ordinary water level, and it was decided to build a concrete arch bridge here, giving as much clear waterway as possible. The approach spans at either end had to be arranged so as to allow sufficient clearance underneath for the passage of highways.

The structure decided upon has a parabolic arch with a span of 50 ft. and a rise of 15 ft. The loading allowed for was Waddell's Class Z engine, the equivalent uniform loading being 4000 lb. per foot of track, with an impact allowance of 73 per cent. The design was carried through by the method outlined in Howe's "Symmetrical Masonry Arches."

The arch span consisted of two reinforced-concrete ribs which support a reinforced-concrete floor by means of columns. Upon the floor are placed 2 ft. of stone ballast, upon which the track is laid. The arch ribs have a uniform depth of 30 in. throughout their length, while the width of the ribs was varied in order to obtain the necessary moment of inertia at each section. The result is that the breadth of each rib is 5.5 ft. near the abutment and 1.25 ft. at the crown of the arch. This design was adopted in order to give the structure lateral stability for resisting the sidewise pressure of flood waters. The arch ribs were reinforced both top and bottom by ¾-in. steel rods and the floor slab and beams of the approach spans were reinforced with Kahn trussed bars of suitable sizes.

Waikele Bridge



Plan and Elevation of Waikele Bridge with Varying Rib Thicknesses

The theoretical maximum compression stresses in the concrete are 438 lb. per square inch at the abutment, 341 lb. per square inch midway between abutment and crown, and 381 lb. per square inch at the crown. The theoretical maximum tensile stress in the steel at the abutment is 7230 lb. per square inch. There is no tensile stress at the crown.

The structure was put in service in the latter part of February, 1913.

The bridge was designed by Carl B. Andrews, chief engineer of the Oahu Land & Railway Company, and built by the railway company's concrete construction gang under the supervision of H. E. McCoy.

Ice Jam on Fraser River Wrecks Bridge Falsework

An ice jam sweeping down the Fraser River in British Columbia on Feb. 12 carried away 250 ft. of falsework which had been erected for the Kettle Valley Railroad bridge at Hope. Work on the substructure was begun about two months ago and the falsework had been extended 750 ft. from the south shore.

Above Hope the river had been tightly packed with icefloes which had drifted down from the upper reaches of the Fraser, and when the temperature dropped suddenly the whole mass commenced to move. The contractors had foreseen this occurrence and one of the costly open caissons which was ready for launching was saved by being secured behind a breakwater. All the men on the work were warned in time to escape, but part of the falsework went out and in so doing precipitated into the river two hoisting engines, a derrick and a concrete mixer. After some difficulty all this equipment was salved and is reported not seriously damaged. The contractors, Armstrong & Morrison, of Vancouver, B. C., still hope to complete the substructure before high water, which is due about May 1. The bridge is to be a double-deck structure supported on four 238-ft. spans.

Limitation of Building Heights

Arguments Advanced against the Proposal Made in Chicago to Substitute a 260-Foot for the Present 200-Foot Limit

At present the height of buildings in Chicago is limited to 200 ft. There has been agitation, however, for the abrogation of this limit and the substitution thereof of a minimum of 260 ft. or more. The proposal has met with opposition, as was to be expected, and Mr. August Gatzert, a Chicago architect, has addressed to the committee on buildings of the city council a letter discussing the objections to the plan. An abstract of the communication follows.

It is a remarkable thing that the proposal to restore the 260-ft. building limit should come at this time. Chicago is struggling with a most vexatious traction problem. The railway-terminals tangle also confronts you gentlemen of the council.

Those two vital subjects are peculiarly involved with the limitation of building heights, for the higher we build our buildings the heavier will be the traffic on our streets. In the railway-terminal reports of both Mr. Arnold and Mr. Wallace both these eminent engineers practically agree that we have not sufficient downtown street space for present needs. They say that use of all our present surface and subsurface street space will not give enough room. Is it not most untimely, then, to ask the city now to increase the limit of building heights, and thus surely aggravate the present perilous and unbearable conditions?

EFFECT ON CONSTRUCTION

The principal argument made in behalf of the 260-ft. building limit, if my memory serves me, was at the time of the introduction of the proposal by Alderman Geiger, that the restriction of 200 ft. had resulted in a recession of building activity in the downtown district. That argument needs no further answer than to remind you that when the restriction was about to go into effect several years ago there was a marked advance of numerous building projects then in the formative stage, and that this was manifested by the issuance of approximately $30,000,000 of building permits for skyscraper constructions during the last month the old rule was in effect. The result has been, in the judgment of men familiar with the needs of Chicago in office space, that the supply exceeds the present demand, that a great deal of office space in the new high buildings is vacant, and that in the filling of others numerous older buildings have been left with a large amount of untenanted space. So much for the need of new office space in downtown Chicago at present. Is not the real reason that building construction has fallen off, then, if such is a fact, that there is no pressing and profitable demand for higher buildings at the present day?

Another argument made by those favoring the 260-ft. limit is that by permitting higher buildings you will encourage the profitable investment of many million dollars which otherwise would not be invested in building. That argument in itself raises the question whether skyscrapers are as profitable investment enterprises as they may seem to the ordinary citizen. As to that I will quote in part the views of two of the best-known real-estate men in Chicago, as recently given in the "Real Estate News."

Mr. Frederick H. Bartlett, head of one of the largest real-estate firms of Chicago, said:

"I do not believe in skyscrapers as investments. The tall building is responsible for raising ground values in Chicago above the possibility of its earning power. When I say that I speak coldly and advisedly. I realize the popular idea is contrary to this truth, but skyscrapers are not profitable investments in any case, except where they are used for individual businesses, and not then unless the necessity of the business requires it to be located on land that has been overvalued by the construction of similar buildings, and a large percentage of carrying expense can be legitimately charged to advertising.

"A three to five-story building, even in the central districts, will pay better on the capital invested than a twenty-story structure, considering the difference in cost of foundation and the depreciation, and the fact that the main and second floors are the valuable space. Let those who believe this is hearsay scream their protests if they choose to do so. The skyscraper in Chicago is an economic and financial blunder."

Albert L. Strauss, through whose agency many millions of dollars have been invested by the Marshall Field Estate, and by the McCormick, Lehman, Rosenwald, Sears, Pardridge and Borland interests, and who is probably the best-known broker specializing in Chicago central property, is quoted in the same journal as follows:

"If anything in Chicago real estate is established beyond question, it is an established fact that the skyscraper is not a good speculative proposition. The skyscraper is a good thing for a monument for a large estate, an insurance or financial institution, or as an advertisement for a business or for a family name, but not as a big revenue producer.

"As closely as I have been able to figure it, I will say that all rentable space in a well planned, well located skyscraper should bring an average of $1.80 per square-foot-year, besides being well rented, having good management, low expenses and few losses of rentals, to net 5 per cent on present-day values. The buildings that will in the long run measure up to that standard are, I may say, mighty few."

EXPERIENCE IN NEW YORK

Further testimony on the economic status of skyscrapers is afforded by New York, where Lawson Purdy, commissioner of taxes and assessments, after many years in public service devoted to studying the skyscraper question, declares that none of the later skyscrapers in New York has proved to be a money-maker. On the contrary, he says they are all merely "monuments, advertisements, or failures." The immediate effect of the skyscraper, he says, is to limit the number of buildings needed and so depreciate the value of property.

"We have ruined the appearance of our city," said Mr. Purdy to the business men of Toronto who asked him to address them on what they ought to do in regard to high buildings, "and impaired the health of its citizens, only to reduce the number of suitable office buildings. High buildings have created a condition of street congestion which is the despair of New York, and conditions have reached such a point that employers in some sections are forced to change the luncheon hour of their employees in order that the streets may not be packed beyond their capacity. Manhattan," he concludes, "is already doomed."

EFFECT ON CONGESTION

Turning aside for a moment from the question of whether skyscrapers pay, let us give thought to their effect upon Chicago's increasing peril of downtown congestion. The skyscraper is the greatest creator of crowds we have in Chicago today. In illustration, consider the bank building now nearing completion on the half block bounded by Adams, La Salle, Quincy and Fifth Avenue. I am told that occupancy of that twenty-two-story structure will embrace 7000 people. In former times, when our six and eight-story buildings were erected with larger office rooms and more hall space it took nearly three blocks in our downtown district to house 7000 people. What does that mean? It means the concentration of the business of other days into one-sixth of its former street area, with a slowing up of movement, due to crowding. This further intensifies that great concentration and so adds to the burdens our streets must bear.

About one-tenth of our central district is now built up with fifteen to twenty-story structures. It seems quite apparent to me, gentlemen, that if our entire central district were built up with twenty-two-story buildings there would not be room enough in the streets for the pedestrians who would be attracted to them, to say nothing of accommodation for vehicular traffic.

Now, gentlemen, as men framing measures for the benefit of the whole people, I ask that you give consideration to the number of people who would be benefited by your restoring the building limit to 260 ft., as against the whole body of our people and the hundreds of thousands of visitors from other cities who would be injured. I have had a very careful computation made of the number of property owners having realty holdings in the downtown district. Between the river and the lake north of Twelfth Street there are only 1550 property owners. Of these, approximately 1250 own land north of Harrison Street, and the number of owners north of Van Buren Street, in the real high-pressure territory, falls to about 1000 individuals and estates.

Not even these 1000 landowners can take advantage of the 260-ft. limitation, however. You must exclude from the list of those benefited all holders of ground now bearing high buildings. Such high structures as exist, by their very existence bar from any benefits in the proposed measure all property owners except those with old improvements; and I respectfully submit that owners of downtown Chicago property are not, as a class, people who need special legislation for the improvement of their financial conditions.

TALL BUILDINGS SHUT OUT SUNLIGHT

Now as to the social effect of the high buildings. To the west of every skyscraper is an area that has forever lost its birthright to the morning sunshine. Eastward from it lies land upon which the sun has permanently set. To the northward it is darkness; chill, damp, and cheerless.

Skyscrapers transform city streets into

gloomy passageways and windy canyons. They dwarf the average structure, obscure light, shut out the much-needed sunshine, foster germ diseases, and are eyesores upon the architectural landscape. It is better for property, for comfort and convenience, for commerce—better from every point of view —that a city should spread out instead of contracting its energies in a limited space. It is better that there should be miles of commodious, well-lighted and well-ventilated six, eight and ten-story buildings than a congested group of twenty-two-story structures.

EFFECT OF LOWER LIMIT ON CITY'S GROWTH

There are men who blindly declare that but for the skyscraper Chicago would not have attained its great size and importance in such a short period of existence. The statement is not true, gentlemen, as is proved by the growth of Berlin, which is the best city in the world to compare with Chicago in the matter of growth. Statistics show that during the last forty years the growth of Chicago and of Berlin has proceeded at an even pace. The two cities started forty years or so ago with about the same population and have run neck and neck ever since—and there is not a skyscraper in all Berlin, where the height of the buildings is actually limited to 72 ft. By regulating the height of buildings Berlin has not in any manner stopped its growth. Instead, however, of having a greatly congested small area for retail business and offices as we have, the business district of Berlin extends for miles; equivalent, I judge, to an area stretching in a wide and solidly built section from North Avenue to Thirty-fifth Street, with its buildings all of a uniform height and similar in architectural design; a uniform skyline has been maintained and the effect is tremendously pleasing to the eye. Berlin has found that such development is a big asset. It attracts business from all over the world. It has made Berlin a close rival to Paris for the attention of Continental travelers, who leave large and increasing sums of money with the merchants of Berlin every year. I venture to say that if this committee could spend a day in Berlin with me and contrast the splendid development universally seen there with the squalid and profitless conditions prevalent in our own city in the various sections near the loop district, no other argument would be necessary to show the fallacy of building skyscrapers.

As you doubtless know, no European city permits the erection of any high buildings. Most of them provide that no structure shall exceed in height the width of the street it faces, so as to allow health-bringing sunshine to enter every possible apartment. Vienna's limit is 60 ft.; Paris, 65, and London's about 100 ft.

MAXIMUM LIMIT 150 FEET

I want to go on record, gentlemen, as favoring a change in the 200-ft. building limit—a change that will reduce the maximum height to 150 ft., or even 100 ft. Further, I hope that some day such a limitation will be made a part of the charter of our city—as in Los Angeles—so as to make it impossible or difficult to periodically bring about changes by ordinance.

It has been urged that as New York has permitted the erection of high buildings we should do the same. I do not need to contrast for you the physical inadequacy of New York in ground area suitable for expansion with our own wide and open territory. But I will urge that New York now recognizes the error of her past ways and is taking steps to stop the erection of skyscrapers.

This is no time for Chicago to take a backward step in the matter of limiting building heights, for the tendency of American cities to-day is toward the lowering of buildings. Cleveland, like Chicago, limits buildings to 200 ft., and so does Newark. The limit in Baltimore is 175 ft.; in Los Angeles, 150 ft., and the same in Portland, Ore. Scranton and Boston impose a restriction of 125 ft. Besides these, Buffalo, New Orleans, Jersey City, Paterson, Denver and St. Louis have relative limits on the height of buildings depending on street widths. This countrywide movement toward restriction will be greatly accentuated as soon as our cities know generally what New York is doing to correct the evil effects of overbuilding.

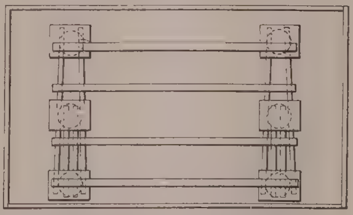
Shoring and Underpinning Elevated Railroad Columns

Method of Support Adopted to Permit Excavation for New Subways

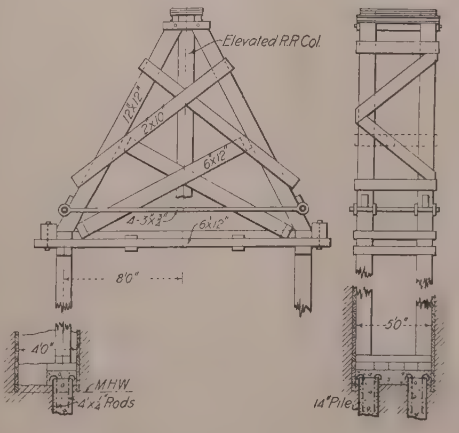
THE elevated railroad in Church Street, New York, is supported at the curb line on steel columns with offset brick foundation piers about 8 ft. square with footings on the sand about 10 ft. below the surface and 2 or 3 ft. above the original ground-water line. In some cases the permanent subway structure will clear these piers and in other cases it will partly support them, but in all cases the excavation for it, about 24 ft. deep, endangers their stability and necessitates temporary shoring or permanent supports to safeguard them against possible undermining by displacement of the fine wet sand.

SHORING

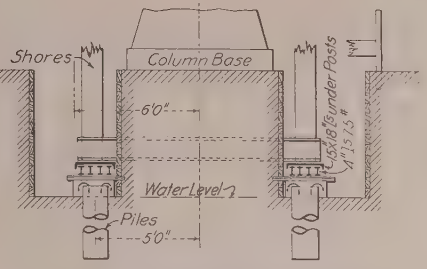
Where it is necessary to modify or replace the old piers the elevated-railway columns and the bottom flanges of the transverse girders are temporarily supported on wooden towers consisting of pairs of A-frames braced together and supported on vertical wooden posts before the subway excavation is made. Small pits are seated down to ground-water level adjacent to the column piers and in them foundation piles are driven below subgrade and carry the vertical posts on which these shoring towers are set.



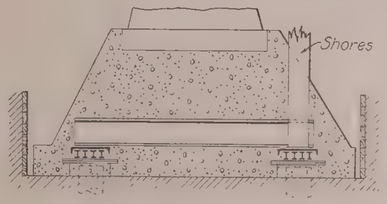
Sheeted Pit with Foundations



Shoring for Elevated Railroad Column



Old Pier Undercut and Underpinned



Pile and Beam Foundations of New Pier

The bases of the towers are secured against transverse spreading by pairs of horizontal eye-bars with their ends engaging pins bearing on blocks bolted to the inclined posts and adjusted if necessary by shims or wedges. When the load of the superstructure is transferred to the wooden towers the old piers are released and the superstructure is maintained in position and adjusted if necessary to compensate for settlement until the subway construction at that point is completed and the new piers, which may rest partly on it, are built and the columns transferred to bearing on them.

UNDERPINNING PIERS

Where the adjacent column piers are clear of the subway structure 4 x 5-ft. pits are sheeted down on opposite sides of the pier to ground-water level about 3 ft. below the pier footing, and in each of them three 14-in. sectional riveted steel pipes are driven 2 or 3 ft. below subgrade by a drop hammer. The interior of the pipe is excavated by a sand auger or by a small orange peel bucket, and the pipes are concreted and capped with 3-in. I-beam grillages. The excavation is completed down to the bottom of the footing around the pier and the foundations are undercut to a depth of about 4 ft., giving clearance for the insertion on each side of four 15-in. I-beams, about 14 ft. long, which are supported on the top flanges of the transverse grillage beams. The 15-in. I-beams are wedged up to bearing against the pier and take a portion of the column load and are engaged in a solid mass of concrete, after which the excavation is made around the pier without engaging its stability.

The work was done by Frederick L. Cranford, Inc., with the approval of the engineering departments of the elevated railroad and the Public Service Commission, which is in charge of the subway construction.

American Concrete Institute

Abstracts of Some of the Papers and Committee Report Presented
at the Tenth Annual Meeting in Chicago, February 16 to 20

Reinforced-Concrete Pavements

By B. S. PEASE
Engineer for the American Steel & Wire Company, Chicago

THE formation of cracks in concrete pavements is the conspicuous fault of a type of pavement low in first cost, offering slight resistance to traffic, while preserving a satisfactory traction, even on steep grades, and possessing a high sanitary value. Cracking may be induced by three factors—poor foundations, contraction during the setting period and natural expansion. The commonly used method of hindering cracking is by building the pavement in small units, with joints, but this is expensive and the joints are unsightly and not durable. Even when protected by steel plates, the line of cleavage is the weak portion of the wearing surface, and it is there that deterioration first occurs.

Steel reinforcement, though its use for pavements dates back only three or four years, appears capable of preventing the formation of cracks under all conditions when properly proportioned and placed. In 1913 at least fifty-six municipalities contained construction of this type, one and two-course pavements being about equally divided. The performance of these pavements indicates the ability of reinforcement to counteract the principal causes of cracking.

Theory of Pavement Reinforcement

Consider those pavements that will be laid on a questionable foundation. The necessity for reinforcement to give structural strength to the slab is evident, regardless of whether the foundation is poor in spots or over the entire area. If the foundation consists of filled material, it is almost impossible, even by the use of a heavy road roller, to prevent future settlement, and no one can tell at what points the settling will occur.

An excellent example of this class of work is shown by a pavement built on spongy land in Oakland, Cal.—a 6-in. slab reinforced near the bottom with a steel mesh, the type most commonly used. Upon especially soft spots a second thickness of the wire fabric was laid at right angles to the other. This roadway is giving good service under a heavy traffic.

In the construction of country roads a part of the metal will usually extend outside the old beaten track, and therefore the foundation will be more compact under the center portion. Even if the center be scarified and rerolled it will be almost impossible to secure a uniform result. This condition in itself will allow a settlement at the outer edges and cracks will form longitudinally unless suitable reinforcement be used near the top of the pavement. When a pavement contracts in setting or because of a reduction in temperature, cracks will form at more or less regular intervals, the distance between them depending largely upon the tensile strength of the concrete. It is for this reason that many engineers advocate a definite close spacing of expansion joints. At the same time they concede that these joints are the weak spots in the pavement; if some other method of construction could be used, therefore, so that the number of these joints could be reduced, its merits should be studied.

Position of Reinforcement

As concrete in itself has no dependable tensile strength, it is necessary to include a reinforcement to supply this deficiency. For several reasons the practice has been to place this reinforcement near the top of the slab. For a two-course pavement the logical position is between the base and wearing courses, where it will not only resist expansion and contraction of the entire slab but will also act as a connecting link between two bodies of concrete having a different mixture of the ingredients and will prevent the formation of cracks along the crown. For single-course work the reinforcement is usually placed about 2 in. below the surface. Although this type is called single course, it must of necessity be placed in the layers in order to include the reinforcement.

The amount of reinforcement to use may vary with conditions, but the limited practice suggests that for country roads, if the expansion joints are placed not more than 30 ft. apart, sectional areas of .049 sq. in. per foot of width crosswise and .038 sq. in. lengthwise of the pavement will furnish sufficient resistance to prevent cracks due to shrinkage during setting, expansion or contraction from temperature changes, or any ordinary inequality of the foundation soil.

Spacing of Joints

The subject of proper spacing of expansion joints should be studied in connection with the consideration of the reinforcement, for the reason that the greater the spacing of joints the greater should be the amount of longitudinal steel.

Past experience points to the fact that the principal change in the length of a concrete pavement is a contraction, and the steel, although it has approximately the same coefficient of expansion as concrete, and will therefore change in length about the same amount, will prevent the shortening effect from being localized at definite intervals and will distribute the total change into innumerable small cracks that will not decrease the wearing qualities of the finished pavement. If the expansion joints are spaced at a greater distance than 30 ft. the amount of longitudinal steel should be increased to at least .1 sq. in. per foot width for spacing up to 100 ft., and the writer thoroughly believes that by the addition of a sufficient amount of longitudinal steel reinforcement it would be possible to construct the roadway without any expansion joints.

For street pavements the early practice was to use a very light reinforcement, but the more recent ones have made use of a heavier material, even for close spacing of expansion joints. In fact, the tendency now is to increase the weight of reinforcement, and since this item is small in comparison to the total cost of the finished work it would appear to be poor economy to use a light material when for a slight additional expense a proper construction can be assured. The average cost for the reinforcement in place ready for concreting varies from 7 to 15 cents per square yard, depending upon the weight of reinforcement used. The same recommendations and the reasons therefor that have been given for necessary reinforcement for country roads will also apply for city pavements, with the exception that, regardless of the weight of reinforcement used, expansion joints will be required at all street and alley intersections or wherever connected with any permanent rigid construction.

Test of Flat-Slab Floor

By W. A. SLATER
Engineering Experiment Station, University of Illinois

THE first floor above the basement in the new factory of the Shredded Wheat Company of Niagara Falls, N. Y., was tested recently. This is a three-story reinforced-concrete structure of the flat-slab type, divided by columns into 20 x 22-ft. panels. The floor is 7 in. thick in the central portion of the panel and 9 in. throughout the area of 8 ft. 6 in. square surrounding each column, and is designed to carry a live load of 125 lb. per square foot. The columns are octagonal in shape, those of the basement story being 25 in. in the short diameter and ending at the top in 3½-ft. flared heads. The columns of the story above are 23 in. in the short diameter. The reinforcement, all of which is placed in the two directions parallel to the sides of the column, is designed to resist positive moment at the centers of all spans and negative moment at the columns and across the edges of all panels.

Originally 9 panels were loaded to 191 lb. per square foot, after which the load was removed from 6 panels, leaving 3 adjacent central panels loaded. These 3 panels lie in a row and are one span removed from the exterior wall of the building. Finally, the load was removed from all but the central panel of the entire test area, where it was increased to 243 lb. per square foot.

Deformations were measured at 288 gage lines and the results were very consistent among themselves. It was found that the condition of the 3 adjacent panels loaded gave steel stresses at the center of the span more than 50 per cent greater than with 9 panels loaded, and that the stress at the support was about 20 per cent less with 3 panels loaded than with nine. It seems apparent that the tendency of the floor to deform as a cylinder instead of as a saucer, its action as a continuous beam and lateral distribution of stress to unloaded portions of the slab all contributed to these differences between the stresses under 9-panel load and those under 3-panel load. The results of the test seem to check the conclusion arrived at analytically—that the greater portion of the unbalanced moment was carried by the columns and very little by the slab. This conclusion is somewhat in conflict with the observation that there was so great an increase in the stress at the center of the panel when only 3 panels were loaded. In this respect it is typical of the generally observed fact that the results obtained from such tests are usually indicative of the general trend of results, but cannot be applied too rigidly as final conclusions.

Concrete Road Construction in Milwaukee County

By H. J. KUELLING
County Highway Commissioner,
Milwaukee, Wis.

FAILURES of early pavement concrete roads did not deter Milwaukee County from continuing the work. In 1913 22 miles were constructed, one-half by contract and the other by day labor. Some of the changes in methods under which the 1913 pavements were laid are indicated in the following notes. The tar cover on the original concrete, which was of run-of-bank aggregate and had disintegrated badly, peeled off, although precautions were taken to broom the pavement clean before the tar application. Clean glacial screened gravel is now shipped in, often from a distance of 125 miles. Although much of the concrete is placed on an uncompacted sub-base, there are few cracks. With 40 per cent voids a 1:2:4 mixture is used and with 45 per cent voids, a 1:2:3½ mixture.

Joints in 1914 will be laid 50 ft. apart without armor. Last year the 35-ft. slabs did not crack, so the longer interval will be tried. Curing of concrete is especially looked after on windy days. Canvas is spread first, then 1 to 2 in. of earth, which is kept sprinkled for five days. Traffic is excluded for three weeks. Shoulders of gravel and macadam on 18-ft. roads are not necessary, as grass is growing along the 1912 pavements.

This year it is proposed to finish all work in October to insure plenty of time for final setting before the advent of frosty weather. Average costs per square yard of 10,510 ft. of 18-ft. roadway with an average haul of 1 mile were: Gravel and sand, f.o.b. car, 27½ cents; macadam shoulders, 3½ cents; hauling and labor loading, 27½ cents; cement at $1.65 per barrel, 42 cents; labor depositing, etc., 18¾ cents; foremen, 1 cent; steel for joints 35 ft. apart, 3⅓ cents; felt, ¾ cent; compliance with compensation act, 3 cents; machinery depreciation, 3 cents—total, $1.30 1/3. The average for both contract and day labor roads was $1.54. No allowance in any of these figures is made for overhead charges.

A SUSPENSION bridge with a 605-ft. span, anchored to two adjacent 302-ft. spans instead of to shore anchorages, is being built over the Rhone at Cologne and will contain about 6500 tons of nickel steel and 2000 tons of carbon steel.

Specifications for Drain Tile

By A. MARSTON
Dean of Division of Engineering, Iowa State College

TILE drains, either clay or concrete, 36 in. in diameter are now common; those or 48 in. are not unknown, and it is with these large sizes that cracking occasions the most trouble. The need of standard specifications, designed to prevent cracking and minor mishaps, has been recognized by the American Society for Testing Materials, which three years ago appointed a committee to make the investigations and collect the data prerequisite to the compilation of such specifications. It has just completed a series of 600 strength tests and has under way extensive absorption studies at the University of Wisconsin. The principal topics on which information is being sought are:

1. The adoption of standard loads for different depths and widths of ditches and varieties of soil which drain tile are liable to have to carry.
2. The determination of a factor of safety which experience with sound pipe in actual ditches has shown to provide reasonable safety against cracking.
3. The division of drain tile into classes A, B, C, D, etc., as has already been done with water pipe, and the specifying of the minimum bearing strength per linear foot for each class.
4. Limits of depth and width of ditches for each main variety of soil where drain tile of each class may be used without special precaution in laying.
5. An additional allowance, possibly stated as a percentage, which shall be granted for care in laying equal to that given in the best sewer construction practice.
6. A specification permitting the use of drain tile in depths and widths of ditches exceeding the limits specified in topic 4, on condition that the pipe be strengthened by laying in a cradle of concrete.

Tests of Concrete

Committee Report, Sanford E. Thompson, Chairman

RECORDS of tests of concrete models made during the past year and the conclusions inspired by the results are offered in a report submitted Feb. 20 to the American Concrete Institute by the committee on specifications and methods of tests for concrete materials. This committee is composed of Sanford E. Thompson, consulting engineer, of Boston; Cloyd M. Chapman, engineer of tests, Westinghouse, Church, Kerr & Company, of New York City; Russell S. Greenman, resident engineer, State testing laboratory, Albany, N. Y.; William M. Kinney, assistant inspecting engineer, Universal Portland Cement Company; Arthur N. Talbot, professor of municipal and sanitary engineering at the University of Illinois, and Guy Wise. The purpose of the work was to determine the size and shape of specimens to recommend as a standard for uniform laboratory and field tests, as well as the relative strengths of test pieces of different shapes, sizes, ages and consistencies for comparison with that of the standard pieces.

INFLUENCE OF SHAPE AND SIZE

The various tests were made in the laboratories of the University of California, University of Illinois, University of Wisconsin and the Massachusetts Institute of Technology. To compare the strengths of pieces of different lengths—especially the strengths of cubes or cylinders whose lengths equal their diameters with those whose lengths are double their diameters—there were made prisms 4 in. square and another set 8 in. square in lengths varying from half to six times their widths, and cylinders from 4 to 12 in. in diameter and height. All of the specimens were of a 1:2:4 mixture and were tested at the age of three months, except those otherwise noted. Table 1 gives the results for the prisms, showing the ratios of strength based on that of a prism whose length is twice its width. Each value is an average of four tests.

TABLE 2—RELATIVE STRENGTH OF CONCRETE CYLINDERS OF DIFFERENT SIZES

Cylinder		Average breaking strength in pounds per square inch			
Diameter, in.	Height, in.	Univ. of Ill.	Univ. of Wis.	Mass. Inst. Tech.	Average
4	4	3154	2570	2662	2795
6	6	3386	3200	3042	3209
8	8	3350	3140	3705	3398
10	10	3141	2890	3117	3049
12	12	3012	2965	....	2988

If the ratios be expressed in terms of a cube, it will be seen that a test piece half the height of a cube is 50 per cent stronger than the cube, while the strength of a prism of double the height of a cube is about 73 per cent that of the cube.

The variation in strength of test pieces of different height is due probably chiefly to the heads of the machine which confine the test piece. In actual construction, however, wherever the height is small in proportion to the width there may be similar restraint.

The relative strengths of cylinders of different sizes is given in Table 2. The size of the coarse aggregate was ½ to ¾ in. and the age, proportion and number of tests are as in the first series.

A comparison of cylinders with cubes or prisms is given in Table 3. The cube or square prism is slightly stronger—about 4 per cent on the average—than the cylinder whose diameter is equal to the side of the square. This may be due not so much to the variation in making the test piece as to the restraint of the heads of the machine.

TABLE 1—RELATIVE STRENGTHS OF CONCRETE PRISMS OF DIFFERENT HEIGHTS

		Prisms 4 in. square				Prisms 8 in. square			
			Average compressive strength, pounds per square inch				Average compressive strength, pounds per square inch		
Ratio of height to width	Average ratio of strength	Height of prism, in.	Univ. of Ill.	Univ. of Wis.	Mass. Inst. Tech.	Height of prism, in.	Univ. of Ill.	Univ. of Wis.	Mass. Inst. Tech.
0.5	2.09	2	6485	4320	5046	4	5408	4730	....
0.75	1.66	3	5170	3245	3672	6	4192	3596	4242
1.0	1.38	4	3811	2915	2688	8	3898	3143	3666
1.5	1.05	6	3306	2075	2288	12	2948	2260	2301
2.0	1.00	8	2623	2265	1993	16	2981	2263	2342
3.0	0.97	12	2732	2175	1910	24	2818	2146	2590
4.0	0.94	16	2137	2423	1976	32	2689	2145	2196
6.0	0.88	24	2513	2305	1883	..	....	....	....

The growth in strength of test pieces of different consistencies for ages ranging from seven days to two months is given in Table 4. Six-inch cylinders were used. Values for 8 x 16-in. cylinders may be obtained by dividing the values given by 1.37. Except where indicated to the contrary, "normal consistency" prevailed throughout the different series of tests. Because of the difference in the effect of different sands upon the consistency, it was impossible to specify a definite percentage of water. Tests made by members of the committee indicate that the most uniform degree of consistency can be obtained by adopting a consistency test, which consists in filling a conical form with concrete, immediately inverting this, and by repeated trials finding the exact amount of water which will cause the cone to begin to slump when the form is removed. A dry mix is of course unsatisfactory, while it is almost impossible to describe a very wet mix which will insure uniformity.

TABLE 3—COMPARATIVE STRENGTH OF CONCRETE PRISMS AND CYLINDERS OF DIFFERENT SIZES

Size, In.	Average compressive strength in pounds per square inch							
	Univ. of Ill.		Univ. of Wis.		Mass. Inst. Tech.		Average	
	Prisms	Cylinders	Prisms	Cylinders	Prisms	Cylinders	Prisms	Cylinders
6 x 6	3711	3290	3010	2690	3575	3222	3432	3067
8 x 8	3521	3374	3135	2965	3917	3165	3524	3168
6 x 12	2547	2351	2245	2825	2440	2297	2411	2491
8 x 16	2759	2769	2260	2370	2496	2934	2505	2691

It is appreciated by the committee that the normal consistency selected is not nearly so wet as is ordinarily used in reinforced-concrete construction. In actual construction, however, the concrete is machine mixed, which tends to give a higher strength than hand-mixed concrete, but the difference would not be marked when the concrete is mixed by hand in very small quantities, as was the case in making these test pieces. Furthermore, incidental tests of pieces of concrete cut out from the interior of the concrete in actual structures, while not as yet by any means conclusive, tend to indicate a higher strength than can be obtained normally from individually molded test pieces.

TABLE 4—COMPARATIVE STRENGTHS OF 6-IN. CONCRETE CYLINDERS OF VARIOUS CONSISTENCIES AT DIFFERENT AGES

Age	Average compressive strength in pounds per square inch											
	Univ. of Ill.			Univ. of Wis.			Mass. Inst. Tech.			Univ. of Cal.*		
	Dry	Normal	Wet	Dry	Normal	Wet	Dry	Normal	Wet	Dry	Normal	Wet
7 days	1751	1390	1103	1690	1580	533	2047	1740	965	1083	724	521
14 days	2140	1775	1354	2795	1905	600	2742	2320	1372	1802	805	676
21 days	2658	1816	1623	2450	2095	722	2594	2396	1464	2182	1093	834
28 days	2615	1820	1657	2380	2430	860	2679	2882	1895	2413	1225	909
2 mo.	3056	3063	2410	2485	2340	787	2761	3092	1830	2659	1560	1157
6 mo.	3941	3431	3281	3375	3860	1451	....	....	....	3485	2145	1304

*These values should not be used in averaging, as the limiting conditions do not agree with those at the other laboratories.

VARIATIONS IN CONDITIONS OF STORAGE

At the University of Illinois the test pieces were stored for their regular tests in damp sand. To compare the effect of different methods of storage, test pieces were placed in damp sand, air, water, and in damp sand after having been coated with paraffine. Table 5 gives a comparison of the results for different consistencies and at different ages.

In Table 6 is presented a short series, also made at the University of Illinois, showing the effect of keeping the test pieces in the form for different lengths of time, while the heads were coated with paraffine. Each value is an average for five 6-in. cylinders.

CONCLUSIONS

The following conclusions deduced from the tests are offered by the committee.

The best shape of test piece is a cylinder. A height of double the diameter presents advantages over other proportions. Tests of similar cylinders show slightly less variation from each other than tests of square prisms or cubes. Where the height is double the diameter, the effect upon the strength of slight inequalities in height of different test pieces is eliminated.

Cubes, cylinders or prisms not shorter in height than their least diameter can be used for comparative tests. For comparison with test pieces of standard shape the strength of these may be corrected by a ratio.

The smallest dimension of the test piece should be at least four times the size of the coarsest particles of stone.

The shape of the test piece appreciably affects the strength.

The strength of test pieces increases as the height decreases. Assuming a test piece whose height is double the width as a basis for comparison, a cube of the same mix will have about 37 per cent greater strength and a test piece whose height is half its width, about 109 per cent greater strength. As the length of the test piece becomes greater than twice the width, the strength decreases slightly.

TABLE 5—COMPARATIVE STRENGTHS OF CONCRETE SPECIMENS AT DIFFERENT AGES AND CONSISTENCIES STORED UNDER DIFFERENT CONDITIONS

Consistency	Water in mixing, per cent	Storage	Compressive strength at different ages, in pounds per square inch				
			7 days	14 days	21 days	28 days	2 months
Dry	8.4	Damp sand	1751	2140	2658	2615	3056
Normal	9.3	Damp sand	1390	1775	1816	1820	3063
Wet	10.2	Damp sand	1103	1354	1623	1657	2410
Normal	9.3	Air	1481	2061	2126	2116	2232
Normal	9.3	Coated with Paraffine Damp sand	....	....	....	2314	2521
Normal	9.3	Damp sand*	....	....	....	....	2734
Normal	9.3	Air*	....	....	....	....	2208

*Made from dry stone; for all other test pieces the stone had been thoroughly wet before mixing.

Tests of similar concrete made with different percentages of water tend to confirm conclusions previously established, that an increase in quantity of water in mixing reduces the strength of the concrete to a marked degree and that this reduction is especially marked at the earlier ages.

The growth in strength with age, using different consistencies of concrete, can be estimated.

The higher loads carried by test pieces which are shorter than one and one-half diameters are ordinarily attributed chiefly to the effect of the restraint against lateral swelling of the test pieces under load, which is developed by the friction between the bearing plates of the testing machine and the ends of the test pieces.

TABLE 6—COMPARATIVE STRENGTHS OF CONCRETE WITH FORMS REMOVED AT DIFFERENT PERIODS

Treatment of ends of test piece	Forms and paraffine removed at age of	Storage after forms removed	Compressive strength at age of three months, pounds per square inch
No paraffine	1 day	Air	1978
Paraffine	7 days	Air	2343
Paraffine	30 days	Air	3166
Paraffine	90 days	Tested damp.	2806

Researches in literature and tests by individual members of the committee indicate that the strength of concrete of given proportions increases as the size of the coarse aggregate increases. In the present series the results on this point are inconclusive, although tending in this direction.

The size of the test piece appears to affect the strength to a certain degree, but because of varying results in different laboratories, no definite conclusion has been drawn. The method of storing the test pieces has a marked influence upon the strength of the concrete.

RECOMMENDATIONS AND PLANS

It is recommended tentatively that the shape of the standard concrete test piece, for laboratory or field, be a cylinder having a length of twice the diameter. The diameter should not be less than 6 in. except with very fine stone, when 4 in. may be adopted. It appears advisable that the diameters of the cylinder should be at least four times the maximum size of the coarsest particles of the aggregate. The 8 x 16-in. cylinder which has been adopted by the joint committee on concrete and reinforced concrete is a satisfactory size when shipment of materials or other limiting condition does not preclude its use.

The strength of cubes or cylinders having a length equivalent to the diameter can be approximately converted to strength of cylinders of double the diameter by multiplying by 0.73.

For field tests of concrete in actual construction, concrete should be taken from the loose mass after it is dumped from the barrow or other receptacle and before it is tamped or otherwise compacted.

Field test pieces should be embedded completely in sand located near the site of the structure and the sand kept continually moist until ready to ship to the laboratory. The test pieces for shipment should also be packed so as to retain their moisture.

Tests are planned to determine the relative strengths of test pieces made in the laboratory and those cut out of a structure, and to determine the effect of sands of various degrees of fineness upon the strength of concrete. Some of this work is already under way.

To carry on properly an investigation of sand there is needed, according to the report of the committee, a special investigator. Frequently cases are brought to notice of defective concrete made from sand good in appearance but containing elements of weakness which could be detected by a scientific study. Such an investigation will require funds and the committee is considering the problem of raising these.

Concrete Pavement in Traction-Engine Factory

CONCRETE pavements exclusively for traction-engine use are being built throughout the yards and shops of the Avery Company at Peoria. For driveways the slabs are 15 in. thick, of 1 part Lehigh Portland cement and 7 parts pit-run gravel, the latter being excavated on the company's property by an Albrecht excavator, which loads the 1½-yd. wagons in about three minutes. Edges of the pavement are protected from spalling by a 2 x 8-in. plank laid flat and flush with the surface of the road. The planks are secured to the concrete by bolts with countersunk nuts and washers spaced on 2-ft. centers so as to permit renewals to be made. While a 1 to 2-in. wearing surface of rich mixture is placed, it is the intention to keep the surface covered with from 2 to 4 in. of cinders so as to eliminate excessive wear on the concrete from the cleats on the drivers of the engines.

A long life is expected of the pavements so protected, for floors in the erecting and testing shops placed four years ago and recently inspected by a representative of the Engineering Record appeared in fair condition and still good for several years of service. These floors were laid in small slabs. a practice not now followed, and spalling at the unprotected joints was apparent in many cases.

Book Reviews

The "American Year Book" for 1913 follows the lines of that for 1912, with the same number and order of departments, but with a revised subdivision of topics. A feature of the issue is the review of the first year of the present National Administration and the achievements of the first session of the Sixty-third Congress. The last chapter contains an American chronology, a foreign chronology, an American necrology and a foreign necrology. (New York and London, D. Appleton & Company.)

"Die Geistigen Mittel des Technischen Fortschrittes in den Vereinigten Staaten von Amerika" is the title of a report to the Vereines Deutscher Ingenieure by Conrad Matschoss, of Berlin. The report, which is the result of a journey to the United States in the fall of 1912 to study the progress of technical education, has previously appeared in the "Zeitschrift des Vereines Deutscher Ingenieure." It contains 63 pages dealing with the technical schools of lower and higher standing, coöperation of the industry with the technical education, literature and the technical press and the technical societies. A part of the book describes the apprenticeship courses that several of the larger manufacturers have established. It is gratifying to learn the high opinion the author has of the technical educational methods in America.

The United States Geological Survey has recently issued the following water-supply papers: No. 295, 99 pages, entitled "Gazetteer of Surface Waters of California—Part I, Sacramento River Basin," by B. D. Wood, under the direction of John C. Hoyt; No. 302, 90 pages, "Surface Supply of the United States—Part II, South Atlantic Coast and Eastern Gulf of Mexico Drainage Basins," by M. R. Hall and C. H. Pierce, under the direction of M. O. Leighton; No. 303, 112 pages, "Surface Water Supply of the United States—Part III, The Ohio River Basin," by A. H. Horton, M. R. Hall and H. J. Jackson, under the direction of M. O. Leighton; No. 319, 445 pages, "Geology and Ground Waters of Florida," by George Charlton Matson and Samuel Sanford; No. 320, 231 pages, "Geology and Water Resources of Sulphur Spring Valley, Arizona," by O. E. Meinger and F. C. Kelton, with a section on agriculture, by R. H. Forbes; No. 333, 90 pages, "Ground Water in Boxelder and Tooele Counties, Utah," by Everett Carpenter; No. 334, 96 pages, "The Ohio Valley Flood of March-April, 1913" (including comparisons with some earlier floods), by A. H. Horton and H. J. Jackson, and No. 337, 77 pages, "The Effects of Ice on Stream Flow," by William Glenn Hoyt.

The thirty-fourth annual report for the fiscal year ended June 30, 1913, of the Director of the United States Geological Survey to the Secretary of the Interior has also appeared in its printed form.

"DIE INSTANDSETZUNG ALTER EISENBAHN-TUNNEL." By Erich von Willmann, Doktor-Ingenieur, Royal Building Commissioner, Assistant Professor of Earth and Tunnel Construction at the Royal Technical University in Aachen. Paper, 7¾ x 11¼ in.; 71 pages; 41 text figures. Leipzig, Emmanuel Reinecke. 75 cents net.

This work on repairing old railway tunnels fills a need in technical literature, as the repair of old tunnels has become of even more importance than the construction of new ones. The author has gone into the subject with German thoroughness. The book is divided into four main parts: General matter for the repair of old railway tunnels, technical details of the repair, results of tunneling work in rock and cost data.

In the first part the author has two chapters, the first dealing with the causes of deterioration of tunnel masonry, such as decrease in strength of the rock, increase in seepage into the tunnel, action of the water, deterioration, action of vegetable growths and influence of traffic. The second chapter treats of ways and means to prevent such deterioration.

The major portion of the book is devoted to the second part, with its five chapters dealing with shoring of tunnel masonry, uncovering of tunnel arches, waterproofing and draining of uncovered arches, replacing linings and waterproofing them.

The most interesting part of the book is that dealing with the results of tunneling in rock. This section contains a diagram showing how the pressure of the rock changed during the construction of the Hönebach tunnel in Germany. The author's cost data will be of little value to American engineers, as they are based on German costs of labor and materials. The book is well written, however, and its illustrations are happily chosen.

ECONOMICS OF INTERURBAN RAILWAYS. By Louis E. Fischer. Cloth, 7¾ x 5 in.; 116 pages. New York, McGraw-Hill Book Company, Inc. $1.50 net.

This book is written for the promoter of and investor in electric interurban railways, outlining for the non-technical man the elements of operating revenues and expenses and cost of construction. After a short historical chapter the author presents a chapter of classifications and definitions, in which he gives general characteristics of what he calls normal and abnormal railways.

In the discussion of operating revenue and expenses the classifications prescribed by the Interstate Commerce Commission are given. The author indicates how to determine what may be expected in the way of revenue from passenger business, freight handling and other sources, and presents statistics of existing roads. Similar statistics are given covering operating expenses. The forty-four items of cost of construction prescribed by the Interstate Commerce Commission are discussed individually and unit costs given—figures with too wide limits to be of great value to the engineer, but useful to the prospective investor.

The economic relation of all of these elements is then discussed, and the net returns to be expected from several hypothetical roads are given. The largest item in these figures—operating revenue—is obtained by multiplying the intermediate population by a per capita figure, which figure is probably capable of such variation as to render the results of doubtful value. The entire book, however, should assist the prospective promoter or investor in differentiating between the good and the bad investment, and that, the author states in conclusion, is its purpose.

GRAPHICS AND STRUCTURAL DESIGN. By H. D. Hess, Professor of Machine Design, Sibley College, Cornell University. Cloth, 6 x 9 in.; 426 pages; 69 illustrations. New York, John Wiley & Sons, Inc. $3 net.
(Reviewed by F. H. Constant, Professor of Structural Engineering, University of Minnesota.)

This text book, which is intended to meet the structural needs of mechanical engineering students, is divided into twenty-two chapters. Chapter 1 gives some of the properties of cast iron, steel and timber, a table of moments and deflections for beams and the properties of standard rolled-steel sections. Chapters 2 and 3 cover elementary graphics for beams, roof trusses and roof bents, and Chapter 4 gives algebraic stress analysis of roof trusses and bridges with parallel chords. For the latter the author prefers the method of coefficients. Chapter 5 takes up elementary influence lines, criteria for wheel-load positions, and the use of the moment table. Chapters 6 and 7 contain the design of I-beams, the properties and strength of rivets, eccentric riveted connections, and the strength and design of columns.

The structural principles thus acquired are now applied to various types of structures—conveyor trusses, trussed gas mains, towers for electric-transmission lines, steel mill buildings, railway plate girders, crane frames and overhead electric traveling cranes. The railway girder may seem out of keeping with the purpose of the book, but is included as a more comprehensive problem to illustrate the principles of the plate girder than a crane runway girder, for example. The author inclines to graphical processes and continues the use of Bow's notation throughout the design of members to the exclusion of the clearer designation by joint numbers.

Chapter 14, containing 35 pages, covers briefly the fundamental principles in reinforced-concrete design. The treatment is as complete as may be expected in this small amount of space. Except for one or two plates one misses the time-saving diagrams and tables now nearly always found in works on this subject. The author assumes the vertical stirrups in beams to be stressed in shear, which is rather at variance with the more accepted belief that their function is mainly tensional.

Chapters 15, 16 and 17 discuss respectively the distribution of pressure under foundation footings, the design of brick, steel and reinforced-concrete chimneys and the graphic and algebraic determination of earth pressure against retaining walls by Coulomb's theory, with numerical designs of masonry and counterforted reinforced-concrete walls. Chapter 18 discusses the pressure of coal, sand and similar refractory materials upon the sides and bottoms of shallow bins. The methods of the preceding chapter for earth pressure are employed. The algebraic formulæ for ten cases most likely to occur are inserted, but the author prefers the graphical method which is employed in the following numerical examples. Stresses and design of various forms of bins are worked out in detail. This subject is not generally covered in structural text-books and should prove a valuable feature of the book.

Chapters 19 and 20 are descriptive, covering various types of floors, walls and roofs, with a number of full-page cuts of mill-building details. Chapter 21 gives specifications in accordance with standard practice for structural steel, mill buildings, deck plate-girder railway bridges, and concrete (plain and reinforced). The book closes with 195 problems, which should add greatly to its value for class purposes.

The book is clearly written and well illustrated by numerical examples. While it covers very little new ground in the elementary structural text-book field, it is well suited for the author's purpose, viz., for a short course for engineering students whose major interest lies in some other direction.

Letters to the Editor

Reinforced-Concrete Standpipe with Sliding Base

SIR: I noticed in the Jan. 10 issue of the Engineering Record, page 43, an article on "A Reinforced-Concrete Standpipe with Sliding Base," by William Mueser, in which attention is called to the particular feature of this design, namely, the independence of the side walls from the base. It has been customary to run the bottom reinforcing well up into the side walls and make the bottom continuous with the sides. This feature is mentioned in the paper as distinctly new and is called the "Mueser type." It is further stated that it is "protected by United States letters patent, granted and applied for."

More than a year ago the writer, after making a study of reinforced-concrete standpipes, came to the same conclusion as Mr. Mueser, namely, that there was no advantage gained by carefully connecting the bottom and sides. In a design prepared for his students at that time he abandoned this connection and showed a joint practically identical with that shown in the drawing on page 44 of Mr. Mueser's article. He has discussed this feature with engineers engaged in work of this character and believed this type to have been a new departure until his attention was called to a letter in the "Engineering News" of Sept. 7, 1911, by G. L. Biederbeck, superintendent of construction, War Department, New London, Conn., and to the No. 2 surge tank of the Ontario Power Company at Niagara Falls.

Mr. Biederbeck in the above-mentioned letter discusses some features of the design of standpipes and advocates a construction essentially the same as that devised by the writer, while R. D. Johnson, hydraulic engineer of the Ontario Power Company, had actually made tests which showed that no asphalt joint was required and had successfully constructed a surge tank at Niagara 70½ ft. high and 79 ft. in diameter simply as an independent vertical section of reinforced concrete pipe resting on a perfectly flat base. The writer understands that the base directly under the pipe was simply coated with a thin layer of clay before depositing the wall concrete, and Mr. Johnson writes that the tank is entirely satisfactory and no cracks have developed.

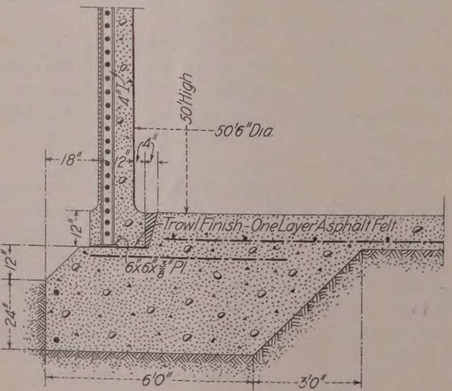
Under these conditions the writer does not see how Mr. Mueser can claim that the principle involved is new or why he should be granted a patent on such a feature. It appears that Mr. Johnson was the first to use this design. It is simply another case of the saying that there is nothing new under the sun.

J. K. FINCH,
New York City. Columbia University.

[A copy of Professor Finch's letter was submitted to Mr. Mueser, whose reply follows.—EDITOR.]

SIR: I am much pleased to have Professor Finch's indorsement of the general principle of disconnecting bottom and shell of circular reservoirs or standpipes as offering advantages over former practice, but it seems to me equally important to avoid the introduction of new structural details, which would defeat the chief advantages to be gained, either entirely or partly.

As stated in the article on the Fulton standpipe, the writer considers as the main purpose in disconnecting the wall and bottom the possibility of having the bottom serve as a foundation only, taking care of all vertical pressures resulting from the weight of the water and from the weight of the circular wall and of having the wall take care only of the horizontal pressures, which it can do best when designed as a simple shell, resting on the base, but provided with a slip joint of such character as will reduce the coefficient of friction to a minimum.



Detail of Tank at Sanderson

The letter in the "Engineering News" of Sept. 7, 1911, by G. L. Biederbeck, to which Professor Finch refers, illustrates and describes a structure in which this purpose is largely defeated. The shell is continuous and of one piece with its foundation, which is fixed in the ground and, therefore, tends to prevent the proper expansion and contraction of the shell under varying water pressure. Moreover, the bottom is supported by a projecting part of the shell wall, and the weight of the water assists in holding the shell at that point, thereby still further interfering with its movements. In the absence of any special reference by Professor Finch where published information about the surge tank, which he mentions, may be found, I am at this time unable to discuss the matter.

Regarding the claim of priority in designing standpipes involving the principles under discussion, the writer will be entirely satisfied to withdraw this claim for himself if it is shown that they originated elsewhere before he developed them and disclosed them to others.

In this connection I may refer to my discussion of a paper by W. W. Clifford read at the meeting of the American Society of Civil Engineers Nov. 15, 1911, and published in the "Transactions," Vol. 74, page 392, as follows: "Two statements in this paper are of peculiar interest to the writer—first, that this reinforced-concrete standpipe is, in watertightness, one of the most successful ever built; and, second, the description of the leak in the wall near the base, consisting of a horizontal crack running nearly half way around the circumference, together with the various unsuccessful efforts made to stop this leak, and the author's assurance that it is the only structural defect.

"All through the paper evidence is to be found of first-class workmanship and of great care in the selection of materials, and yet there was this horizontal crack, notwithstanding which the author claims that this structure is unusually successful, as far as watertightness is concerned. The writer believes that this claim is justified, but only because all reinforced-concrete tanks and standpipes of magnitude leak, some more than others. All have horizontal cracks near the bottom, and all efforts to prevent or close these cracks have been unsuccessful. There is a well-founded and general suspicion that it is impossible to make such structures watertight, and if they are of any magnitude, contractors are not willing to guarantee their watertightness. There is no doubt that in many cases, as in the present one, extreme care has been taken to prevent the leaks and cracks which always appear in the lower part of the wall, but without satisfactory results.

"These and other facts would seem to bear out the writer's conclusion that the trouble with such tanks is not due to the workmanship but to the design, and, in one particular, there should be a radical change, namely, there should be absolute disconnection between the bottom of the tank and the circular wall. This wall should rest on the bottom in such a way as to allow it to expand and contract readily under changing conditions of water pressure. It seems to the writer that the precedent of tying bottom and wall together has been followed too closely in designing standpipes and large water tanks, the same method being used in the construction of vats and small tanks, where enough material can always be used, or, if necessary, wasted, to keep the vessel from breaking or leaking.

"As a matter of fact, a reinforced-concrete tank should be considered as consisting of two elements with two radically different functions: The bottom of the tank supports the weight of the water, the pressure being vertical; the wall has to take care of the horizontal pressure. As all materials are elastic, the wall cannot do its work unless it is allowed to expand—that is, to increase its diameter. There seems to be no good reason for preventing this expansion artificially by tying the wall to the bottom, thereby creating secondary stresses of almost unknown quantity, which the designer, after creating them, tries to take care of by thickening the wall at the base or by extra reinforcement.

"If the circular wall is placed on the bottom and is separated from it by a layer of some anti-friction material, all that is necessary is to waterproof the joint between these two elements—a matter of simple detail. The writer has developed a design along these lines, and this has been adopted for a 1,000,000-gal. tank, 60 ft. in diameter and 48 ft. high, to be built at Sanderson, Tex., by the Galveston, Houston & San Antonio Railway Company. This radical departure from present practice may be of interest."

The tank referred to in this discussion was first designed to be 50 ft. in diameter, and the plans for it, according to my records, were prepared under my direction in my office from Sept. 16 to 22, 1909, or two years prior to the appearance of Mr. Biederbeck's article in the "Engineering News."

I herewith send a blueprint of this plan. It will be noticed that this plan has all the characteristic features of the Fulton standpipe, including the independent bottom and wall, provided with an elastic filler to assure the waterproofness of the tank.

The writer is not particularly anxious for any special credit for any of his work that might be meritorious, but since his right to call the Fulton standpipe of the "Mueser" type has been challenged, it is proper to state that, in view of the above, he still claims the priority in developing, designing and recommending to others the principles above discussed in connection with standpipe design.

New York City. WILLIAM MUESER.

Sewage Treatment by Aeration and Contact in Tanks

SIR: The treatment of sewage by aëration and contact with slabs of slate 1-in. apart, discussed by H. W. Clark and George O. Adams, in your issue of Feb. 7, page 158, is probably the first effort made in our country to experiment in this promising direction. The Massachusetts State Board of Health had stated more than twenty years ago that aëration of sewage had almost no effect upon its oxidation. It, therefore, had been believed by many that forced aëration of sewage-oxidizing beds was comparatively useless. So far as it refers solely to a chemical process this conclusion was right. It was wrong when the process is biological.

The apparatus of the authors, by which they proved the benefit of aëration in the case of biological activity, contained large surfaces of slate or other material upon which abundant growths occurred. They rightly claim that a considerable improvement of the sewage was due to coagulation and clarification, rather than exclusively to the absorption of dissolved oxygen. They further claim that the present experimental work in Lawrence is essentially different from any of the preceding work done along this line, that there is much promise in it and that the purification of sewage may probably be accomplished hereafter upon much smaller areas than has hitherto been believed possible.

The authors mention some "previous investigations" in this direction, referring to Col. George E. Waring, at the Wayne, Pa., sewage works, early in the '90s; Dr. A. Dupre and W. J. Dibdin, in 1884, at the London Experiment Station, and S. K. Hine and Prof. W. P. Mason, who made experiments at Troy, N. Y., in 1892. They then mention Dr. T. M. Drown's experiments at Lawrence and the more recent experiments in New York of Black and Phelps.

The results of the aëration obtained by Waring at Wayne are not mentioned. Messrs. Black and Phelps "showed that certain changes in sewage occur which increased its stability, or rather freed it more or less from its unstable, quickly putrefying elements." Results obtained by all of the other experimenters are quoted as showing "little effect," "oxidation very trifling" and "not hastened by vigorous agitation with air."

About twenty years ago this subject seems to have been better understood in Europe than in this country. Colonel Waring brought the idea of aëration with him from England and tried it not only at Wayne but also at Willow Grove, Philadelphia; these works he showed me at least sixteen years ago (before 1898). Air was forced through a coarse-grained sewage filter by an air pump erected in a nearby building. The results of oxidation were good so far as the appearance of the effluent was concerned, although I never saw any analyses. I remember distinctly that there was an abundance of green algæ growth on the surface of the filter. Colonel Waring attributed the great improvement in the sewage to the oxidation, accelerated by the forced aëration. The latter, however, was soon abandoned because of the expense and the fact that at that time a sufficient purification was obtained without such aëration.

The question of aëration has been discussed for many years, but until recently useful experiments do not seem to have been made, possibly due to the reported failures resulting from aëration without bacterial growth. I searched for such experiments a number of years ago and finally found, nearly six years ago, a case in Leipzig, where an experiment had been made which is not mentioned by Messrs. Clark and Adams. Baurat Franze, through his assistant, Mr. Helbig, forced air into the drain pipes of a coarse-grained experimental sprinkling filter several meters square, the forced air being introduced under a pressure of about ¾ in. The filter was doing the ordinary good work without aëration, but with aëration the efficiency was said to have been increased up to 50 per cent, indicating that the continual fresh-air supply under a slight pressure made it possible to increase greatly the bacterial activity upon the grain surfaces in oxidizing the percolating sewage.

The larger the total bacterial surface to which the percolating sewage is exposed—that is, the smaller the grains—the greater is the extraction of oxygen from the air in a given time per cubic foot of filter bed. On the other hand, the smaller the grains, the smaller is also the pore space, and consequently the greater is the frictional resistance against circulation and a natural replenishment of the oxygen from the outside.

In the Leipzig experiment this resistance was overcome by an artificially increased pressure of ¾ in. The benefit derived from aërating a ripe sewage bed has been known in Europe, and particularly in England, for many years.

The Leipzig experiment caused me to recommend at Atlanta, Ga., a similar aëration of ripe sewage beds (see Engineering Record of Dec. 31, 1910, page 769). Instead of applying an artificial power, I recommended an arrangement by which naturally the ordinary air movement over the beds could be utilized to increase the air pressure in the drains and thus cause a frequent gentle upward movement of air through the beds. An actual measure of the effect of the bacterial activity has not yet been attempted. But the effluent is very satisfactory, notwithstanding the dosing of the beds is greater than usual.

In mentioning previous cases the authors do not refer to the slate slabs of Dibdin at Devizes, for which Dibdin has claimed an effect similar to that now obtained at Lawrence, according to which suspended and colloidal matters are attracted and coagulated by the slate surfaces. Nor do the authors mention the work at Hampton, England, of Dr. Travis, who invented, and I believe patented, the colloidors, which are vertical plates of slate or other material, attracting the suspended and colloidal matter of the sewage, and holding it until it has sufficiently accumulated to slough off from time to time and drop to the bottom of the tank, whence it can be conveniently removed. Dr. Travis also introduced the word "de-solution" to indicate the coagulation of the colloidal matter, which, after de-solution, shrinks, solidifies and adheres to the colloidors, as does the fine suspended solid matter.

The authors in their previous article claim that "this growth or deposit appears to collect mechanically practically all of the suspended matter present and after a few hours the sewage is practically free from such matters. Much of the colloidal matters of the sewage are also coagulated and collected in this way. "Dr. Travis, for over fourteen years past, has claimed these same results from his Hampton tanks. In January, 1906, he and Colonel Jones presented a paper to the Institution of Civil Engineers entitled "On the Elimination of Suspended Solids and Colloidal Matters from Sewage." In this it is said:

"The factor which exerts the paramount influence in causing this separation of solid matter from solution, or pseudo-solution, is, therefore, surface attraction. The colloidal and other substances become particulate upon the surface towards which they are drawn, or with which they happen to come into contact. The value of presenting a larger extent of surface to the liquid cannot be exaggerated, for it not only causes increased deposition, but also shortens, in inverse ratio to the areas of the surfaces, the period during which the phenomena above described are observable."

The contact theory of Dibdin, first advanced, I believe, in 1896, was based upon this same process of attraction and adhesion of the suspended and coagulated matter, as mentioned in Travis' paper.

H. W. Clark was himself one of those who discussed it. He is reported to have said that "surface attraction was a prominent factor in clarification and hence in purification." But he also said: "In the experiments in which air was drawn through sewage, the resulting clarification might well have been caused by the oxidation of iron . . . rather than by the surface attraction . . . ." Is the iron content perhaps a cause for the coagulation of the colloidal matter which the colloidors attract?

I have never been able to see the advantage of the flat surfaces of plates over the round surfaces of the grains of sand or of coarse-grained filters, so far as adhesion of solid matter and bacterial activity are concerned. The total bacterial surface of the granular material is very much greater in area per cubic foot of bed or tank than the total surface of flat plates. Therefore, the total bacterial activity should also be greater.

I doubt also whether the greater thickness of the films of attached solid matter, continuously or intermittently deposited upon the plates from the water, and dropping off by gravity, will allow of as complete and rapid an oxidation of the non-resistant organic matter as will the thinner films on the granular material, which are continuously exposed to air and removed by a trickling water current.

The article of Messrs. Clark and Adams states that their present work of treatment "is essentially different from any of the preceding work along this line." I do not, however, clearly gather the specific difference. We might infer that it is found in the aëration, on the one hand, in tanks containing slabs of slate, continuously or intermittently exposing the flooded sewage to vertical flat surfaces, and, on the other hand, in porous trickling filters continuously exposing the trickling sewage to granular bodies with round surfaces. While it appears to me that the aëration in the latter case, due to the larger bacterial surface, should be decidedly more effective, perhaps nothing short of an experiment on a large practical scale, as suggested, may enable final conclusions to be drawn as to the relative economy of these two processes.

My reason for writing is strongly to endorse the making of further experiments to ascertain definite figures on the increase of bacterial activity induced by aëration.

RUDOLPH HERING,
New York. Consulting Engineer.

[A copy of Dr. Hering's letter was submitted to Mr. Clark, whose reply follows.—EDITOR.]

SIR: I have read with considerable interest the discussion by Dr. Hering of the paper by Mr. Adams and myself on "Aëration of Sewage." It is quite evident, however, that Dr. Hering is discussing a phase of the sewage-disposal problem quite different in all respects from that covered by the paper mentioned. In other words, he is discussing the aëration of sewage filters rather than the aëration of sewage.

In the first paragraph of his communication the statement appears that "the Massachusetts State Board of Health had stated more than twenty years ago that aëration of sewage had almost no effect upon its oxidation. It therefore had been believed by many that forced aëration of sewage-oxidizing beds was comparatively useless."

The Massachusetts State Board of Health began nearly twenty-four years ago to study the forced aëration of sewage filters and a summary and review of its work along this line are given in the report of the experiment station for 1908, pages 365 to 368 inclusive. The average rate of filtration of two of these aërated filters during a period of operation of several years was approximately 713,000 gal. per acre daily—a rate much greater than could otherwise have been obtained—and the non-putrescible character of their effluents was noted and discussed in the report of the board for 1895, page 469. It was also stated by me on page 464 of this report (1895) that "the method has been under investigation at the station for several years and has been exhaustively discussed in the reports of the board. It is a scientific success and perhaps under favorable conditions could be used practically."

Those who are familiar with the early Lawrence reports know that they are full of statements as to the high rates of filtration that could be maintained by forced aëration of sewage-oxidizing beds, and it was amply demonstrated by these experiments, as by other Lawrence work, and so stated, that the process was essentially a biological process. It has become evident, however, as Dr. Hering well knows, that when filters are operated in the manner of the modern trickling filter the natural supply of air is sufficient to maintain higher rates of operation than could be obtained by the filters of twenty-five years ago, operated by the aid of forced aëration.

Again let me state that the paper recently published was upon aëration of sewage in tanks, and the work and articles published by others, referred to in that paper, were upon such aëration rather than upon the aëration of oxidizing beds, so called.

The work of Colonel Waring at Willow Grove and elsewhere is well known to me, and was, as were the experiments at Leipzig, where "air was forced into the drain pipes of a coarse-grained experimental sprinkling filter," not upon aëration of sewage but aëration of sewage filters. Dr. Hering's recommendations for Atlanta, Ga., were along the same line, as he states —"aëration of ripe sewage beds."

The slate beds of Dibdin, so called, were not quoted, as the work done by such beds is quite different. Slate beds were operated at Lawrence, as I have stated before, several years previous to those put into operation by Dibdin, and this fact is noted by Fuller in his book on "Sewage Disposal," page 583, where he states: "So far as known there is no practical experience in America in the operation of slate beds, although, as Mr. Clark states, they originated at Lawrence several years before they were studied by Mr. Dibdin."

Neither did we quote the well-known work of Dr. Travis at Hampton, as this work is also quite different from that described in the article by Mr. Adams and myself.

Dr. Hering quotes from a discussion of mine of the article by Colonel Jones, presented in a paper to the Institution of Civil Engineers in 1906, entitled "The Elimination of Suspended Solids and Colloidal Matters from Sewage." In this discussion I certainly stated that "surface attraction was a prominent factor in clarification, and hence purification"; but it seemed to me, as I expressed in that discussion, that some of the results described in Colonel Jones' paper might well be attributed to clarification caused by the oxidation and precipitation of iron, and I think, if anyone reads carefully Colonel Jones' paper, he may well come to the same conclusion.

Dr. Hering further states: "I have never been able to see the advantages of the flat surfaces of plates over the round surfaces of the grains of sand or of coarse-grained filters so far as adhesion of solid matter and bacterial activity are concerned." Here, again, he is talking of oxidizing filters or filters operated by forced aëration rather than in regard to the phase of sewage treatment by aëration in tanks containing slabs of slate presented in the paper by Mr. Adams and myself.

H. W. CLARK,
Chemist, Massachusetts State Board of Health.
Boston.

Failure of Horse Creek Dam

SIR: I was pleased to see Newton L. Hall's article on the failure of the Horse Creek dam in Colorado published with my article in the Engineering Record of Feb. 14, page 205; the two examinations were made entirely independently. However, I cannot agree with Mr. Hall relative to the ice having any influence whatever in destroying the riprap. Destruction similar to this is so common, even in the absence of ice, that it does not seem necessary to include the ice condition to obtain the same result. On the Belle Fourche reservoir of the U. S. Reclamation Service the riprap was destroyed by the waves rolling high on the facing, the water getting behind the concrete blocks. When the waves receded the hydrostatic pressure behind these blocks lifted them from their bed, causing them to slide down over the face of the remaining riprap.

The sudden lowering of the water at the Twin Lakes reservoir caused the destruction of boulder riprap. The mud behind the boulders was quite soft, and the action was similar; the riprap bulged out and then slipped into the reservoir. The Riverside reservoir riprap acted similarly. I am practically certain that it was the hydrostatic pressure back of the facing which caused it to slip in the case of the Horse Creek reservoir.

JOHN E. FIELD,
Denver. State Engineer of Colorado.

A SCIENTIFIC survey to determine the exact angular distance between the cities of Berlin, Germany, and Washington, D. C., will be made by the German Geodetic Institute at Potsdam in conjunction with the Coast and Geodetic Survey of the United States. Fifty years ago this distance was presumably accurately computed; the purpose of repeating the computation is to ascertain whether the earth has expanded or contracted during the past half century. The Germans will establish the distance between Potsdam and Horta, in the Azores, and the Americans will ascertain the distance from Horta to Washington.